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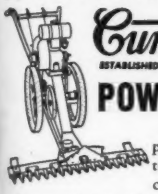

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Devoted to the interests of the engineers and technical officials of cities, counties and states

Vol. 78, No. 4

W. A. HARDENBERGH and A. PRESCOTT FOLWELL
Editors

APRIL, 1947, CONTENTS

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The Editor's Page

Military Problems of the Arctic and Their Solution

Much is appearing in newspapers on the military problems of the Arctic. These are something that we know relatively little about. During World War II, we solved many or most of the problems of the tropics but we learned little about supporting an Army in areas where temperatures may normally be 50 or 60 degrees below zero. If military conditions require that we learn how to support ourselves effectively in cold weather areas, it is a job that has to be done, and engineers must do it.

At this time it appears that our problems are mainly mechanical and personal, that is, they consist of the development of machines that will start and work under conditions of extreme cold; and of methods and equipment for protecting personnel. Water supply and waste disposal are two of the primary problems. Small groups of personnel offer little in the way of problems; it is when we get lots of personnel in a relatively small area that our troubles begin—a situation generally contrary to tropical experience.

Among our readers must be many with experience in cold areas. We would be glad to hear from them, especially in respect to water supply, waste disposal and insect control.

Problems in Housing

A big proportion of the homes that will be built during the coming years to meet our housing problem will be low-cost homes. Because land costs are high in built-up areas, there will be many new developments outside of areas that are or can be served by existing sewage treatment and water supply facilities.

With almost no construction possible during the war years, many other small communities are in the market for water and sewerage construction.

These two facts add up to a volume of work that overburdens established consulting engineers and construction organizations. There is a real possibility that local engineers and surveyors, without adequate experience in the field, will be called on to design water supply and waste disposal systems, and that inexperienced contractors will build them.

Many small plants, some of them poorly designed and others poorly constructed, would pose a most serious public health problem for many years to come; and the problem would be greatly intensified by the employment of untrained operators, which is generally the only kind that a small plant can afford.

Once these conditions occur, they cannot readily be cured, if at all. Prevention to the greatest possible extent is necessary. The sanitary engineering divisions of the various state boards of health are about the only agencies that can mitigate these conditions.

Two steps seem to be indicated: (1) Wherever any doubt exists in regard to design, a thorough check should be made, including on-the-spot field inspections and conferences with the designer; and to insure good construction, some requirement is necessary for an approved resident engineer or inspector. (2) Qualifications for operators should be drawn up, an adequate training program established, and provision made for supervision of operation.

All of this is going to take money, personnel and new ideas, but it will take far less of all three to prevent than to cure.

The Need For and Advantages of Personnel Training

The Bible is the world's most widely available book, but we still need ministers and churches. Our libraries are full of all sorts of books, but we still need schools, colleges and teachers. There are good engineering magazines and good engineering texts, but we still need on-the-job training.

There are few activities that will give better returns than a well-planned and carefully carried out program of training of personnel. These benefits will accrue whether the trainees are employed in highway maintenance, road construction, water and sewage plant operation, refuse collection and disposal, or health department inspection. The benefits accrue not only to the trainees, but to the man who takes the time to teach them. It is a wonderful experience, and one that repays over and over again for the time spent in better understanding of the job, broader knowledge and new ideas.

Our readers will think we are right enthusiastic on the subject of personnel training. That is perfectly correct. Give it a try and get the same enthusiasm, plus plenty of other benefits.

Construction Cost Increases Are General

The increases in present-day construction costs are not confined to the field of municipal engineering, using this term in its broad sense to include highways, streets, sewers, sewage treatment, water supply, water purification, and refuse disposal. And costs may rise even more, though probably not to any large extent.

Officials and engineers must become accustomed and adjusted to these higher costs, which will generally be in line with costs of other services and products. It is idle to believe that they will be substantially reduced. It is just as idle to go ahead and call for bids on the basis of estimates and plans of a year or two ago. The result is a foregone conclusion: Bids will exceed the bond issue, and will be rejected. There will be a further delay, with final revision of plans and/or new estimates, with construction, in the end, at no less than it will cost today and maybe more.

It is reasonable and sensible to realize these facts and to make whatever adjustments are necessary or practicable in plans or in funds available so that work can be initiated now, without delay and without the rigamarole of calling for bids that it is known in advance will be too high and will necessitate replanning and readvertising. A little common sense and a little courage could get a lot of needed work under way quickly.

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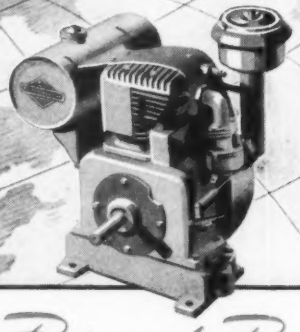
ENGINES



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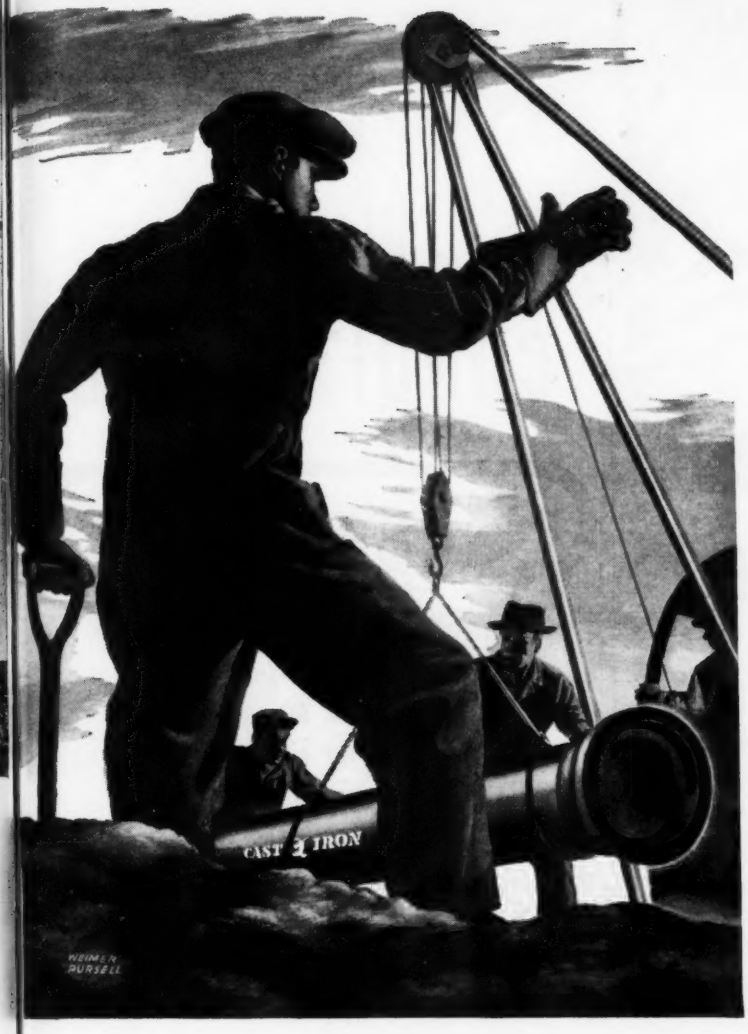

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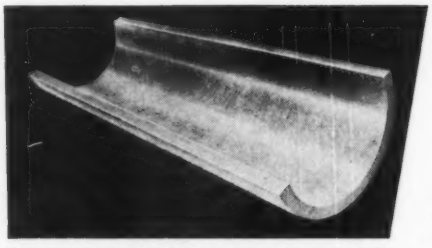
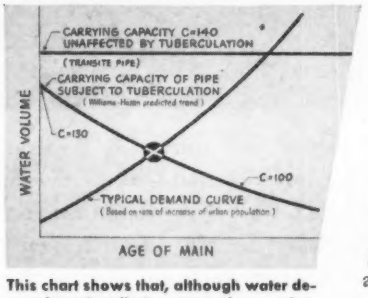


Transite's smooth interior is permanently unaffected by the destructive effects of tuberculation. Its high carrying capacity *stays high*.



This chart shows that, although water demand continually increases, the carrying capacity of water mains subject to tuberculation progressively decreases. Note the much longer period during which a Transite line, represented by the straight curve, continues to meet demands.

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New-design equipment for removing water hardness...

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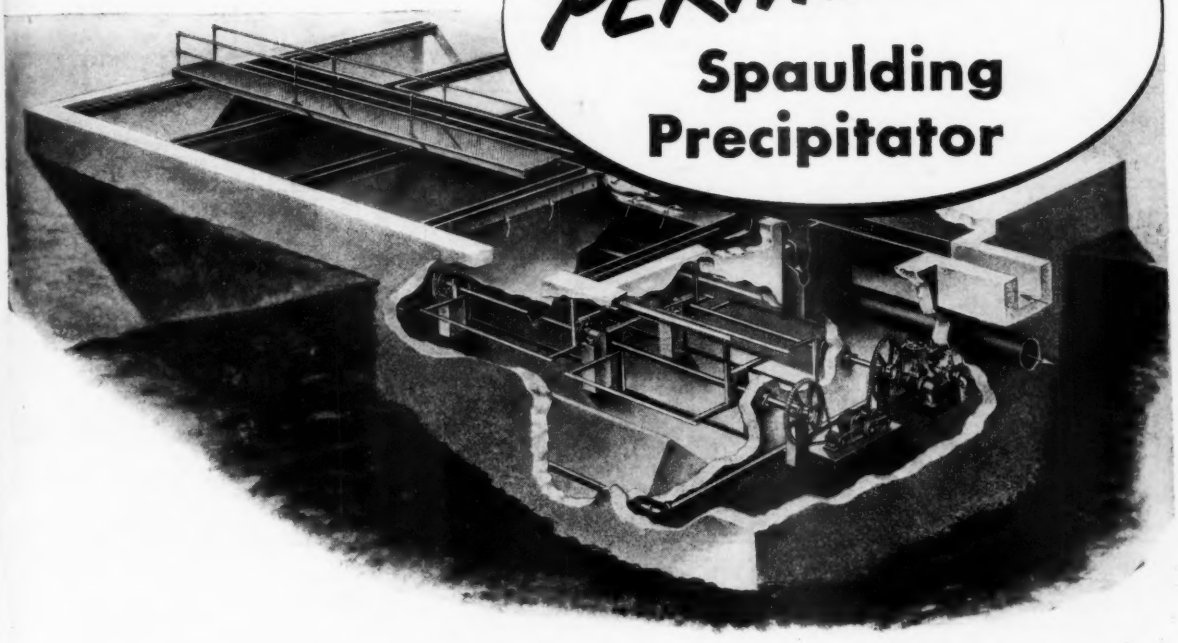
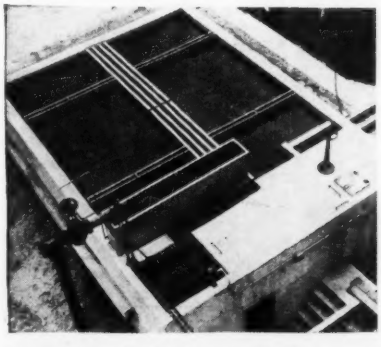


Cuts detention time, saves chemicals, takes only 1/2 the space of former methods



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PRODUCT	AVAILABLE FORMS	COMMERCIAL STRENGTH (MIN.)	SHIPPING CONTAINERS	APPLICATIONS
Aluminum Sulfate $Al_2(SO_4)_3 \cdot 14H_2O$ approx. *(Filter Alum)*	Commercial & Iron Free: Lump • Ground Powdered	17.25% Al_2O_3	Bags Barrels • Drums Bulk Carloads	Coagulant for water and sewage. Dewatering conditioner for sewage sludge. 1% Sol. pH 3.4.
Aqua Ammonia NH_4OH plus Water *(Ammonia Water)*	Colorless Liquid	26°Be. (29.4% NH_3)	Steel Drums Carboys	Used with chlorine to form chloramines for water disinfection.
Ammonium Aluminum Sulfate $Al_2(SO_4)_3 \cdot (NH_4)_2SO_4 \cdot 24H_2O$ *(Ammonia Alum) (Crystal Alum)*	Lump Nut Granular Powdered	11.2% Al_2O_3	Bags Fibre Drums	Coagulant for water. Advantageous for pressure filters. Supplies ammonia for chloramine formation. 1% Sol. pH 3.5.
Sodium Bisulfite, Anhydrous $Na_2S_2O_5$ *(ABS) (Sodium Metabisulfite)*	Powdered	97.5% $Na_2S_2O_5$ (Equiv. 65.5% SO_2)	Fibre Drums	Antichlor. Remove iron and manganese deposits from filter sand. 1% Sol. pH 4.6.
Sodium Silicate $Na_2O \cdot X(SiO_2)$ plus H_2O *(Water Glass) (Silicate of Soda)*	Viscous Liquid	38° to 52°Be. Various Ratios of Na_2O:SiO_2	Drums Tank Cars Tank Trucks	1. Aid in floc formation. 2. Prevent red water corrosion in distribution lines. 1% Sol. pH 12.7
Sodium Thiosulfate $Na_2S_2O_3 \cdot 5H_2O$ *(Hypo) (Sodium Hyposulfite)*	Crystals: Prismatic Rice Selected Universal Granular	99.75% $Na_2S_2O_3 \cdot 5H_2O$	Bags Barrels Fibre Drums	Antichlor. Water solution is neutral.
Sulfuric Acid H_2SO_4 plus H_2O *(Oil of Vitriol)*	Corrosive, oily liquid Various strengths	66°Be. (93.19% H_2SO_4)	Bottles Carboys Drums Tank Trucks Tank Cars	1. Reduce pH and alkalinity. 2. Regenerate carbaceous zeolites and ion exchangers. 3. Activate Baylis Silicate.
Potassium Aluminum Sulfate $Al_2(SO_4)_3 \cdot K_2SO_4 \cdot 24H_2O$ *(Potash Alum)*	Lump Nut Granular Powdered	10.7% Al_2O_3	Bags Fibre Drums	Coagulant for water. Slow, even rate of solubility desirable for solution pot feeders. 1% Sol. pH 3.52.
Sodium Sulfite, Anhydrous Na_2SO_3 *("Sulfite")*	Granular Powdered	98.5% Na_2SO_3	Bags Fibre Drums	Antichlor, oxygen remover. Weak solutions absorb oxygen readily. 1% Sol. pH 9.8.
Sodium Sulfate, Crystal $Na_2SO_4 \cdot 10H_2O$ *(Glauber's Salt)*	Crystal & Needle Crystal	96% $Na_2SO_4 \cdot 10H_2O$	Barrels Bags Drums	Neutral Solution. Boiler water treatment (maintenance of sulfate-carbonate ratio).
Sodium Sulfate, Anhydrous Na_2SO_4	Powdered	99.5% Na_2SO_4	Bags Barrels	Neutral Solution. Boiler water treatment (sulfate-carbonate ratio)
Trisodium Phosphate $Na_3PO_4 \cdot 12H_2O$ *(TSP)*	Crystal	98.5—103% $Na_3PO_4 \cdot 12H_2O$ (Equiv. 19% P_2O_5)	Bags Barrels Fibre Drums	Boiler water treatment. Cleaning compound. 1% Sol. pH 11.8-12.0.
Disodium Phosphate, Crystal $Na_2HPO_4 \cdot 12H_2O$	Crystal	98% $Na_2HPO_4 \cdot 12H_2O$ (Equiv. 19.5% P_2O_5)	Bags Barrels Fibre Drums	Boiler water. (Calcium and magnesium precipitation.) 1% Sol. pH 8.4.
Disodium Phosphate, Anhydrous Na_2HPO_4	Powdered Flake	96% Na_2HPO_4 (Equiv. 48% P_2O_5)	Same	Same as Crystal, but stronger product.
Sodium Fluoride NaF *(Fluoride)*	Powdered (white or blue colored: Nile Blue) Light or dense	90% and 95% NaF	Bags Barrels Fibre Drums	Fluorination of water supplies. (For information, consult with local health officers.)

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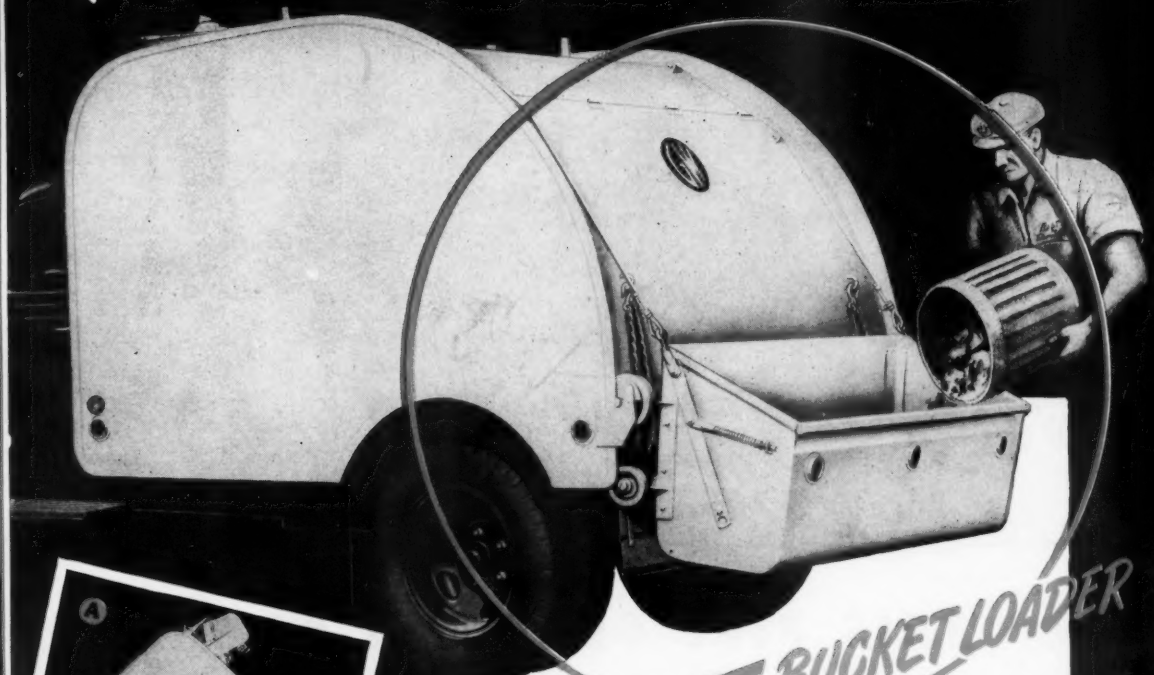

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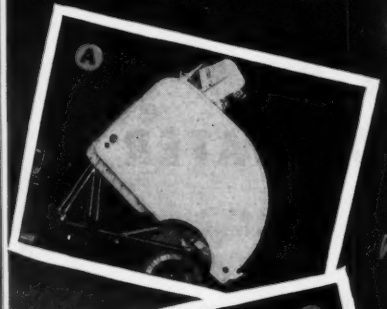

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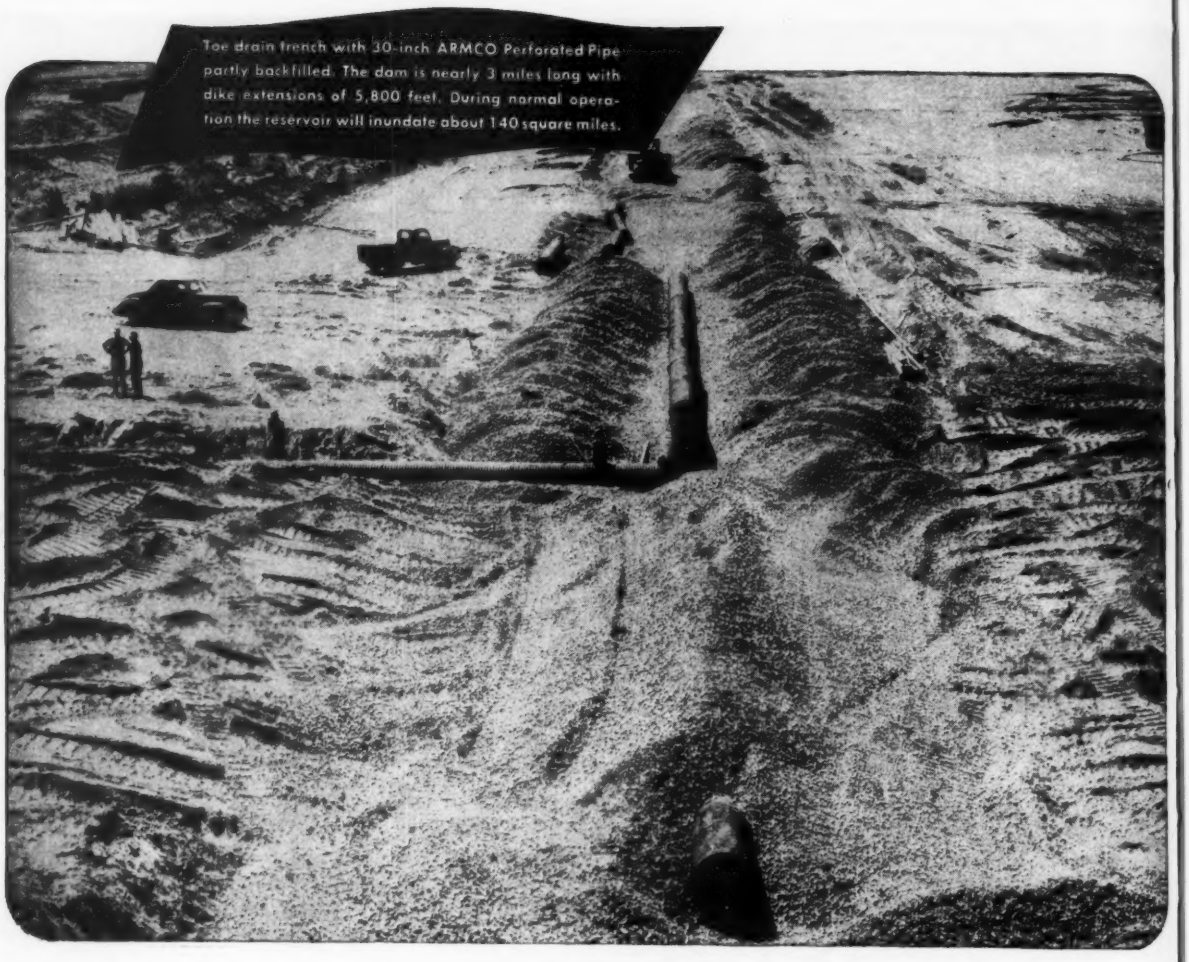
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PUBLIC WORKS MAGAZINE . . . April, 1947

VOL. 78. NO. 4

How to Design Asphaltic Concrete Paving Mixtures

Detailed steps in the various procedures for designing and proportioning asphaltic concrete paving mixtures are adapted from Bulletin C-14 of the Texas Highway Department

AGGREGATES intended for use in paving work should be tested in a properly equipped laboratory. Samples generally should be not less than 50 pounds, and must represent truly the quality and grading of the material. The aggregate is oven-dried; a screen and sieve analysis is made, using screens in accordance with the grading requirements of the particular mix, and 10, 40, 80 and 200-mesh sieves; and the specific gravity is determined. The quantity of each type of aggregate available, and its relative cost, should be determined, so that economy can be secured and the aggregates combined in as nearly as possible the ratio in which they are produced.

From the data on availability and cost, and the screen and sieve analyses, aggregates are proportioned to meet the grading requirements of the specifications. This may require several trials; however, for the purpose of this article, and to avoid long and complicated procedures favorable analyses have been selected. For example, assume a standard specification for hot-mix asphaltic concrete, as follows:

Table 1

⅝" to ½"	0-3%	40-80	5-25%
½" to ¼"	25-45%	80-200	5-25%
¼" to 10	15-35%	Passing 200	2-10%
10 to 40	0-25%	Coarser than 10	50-65%

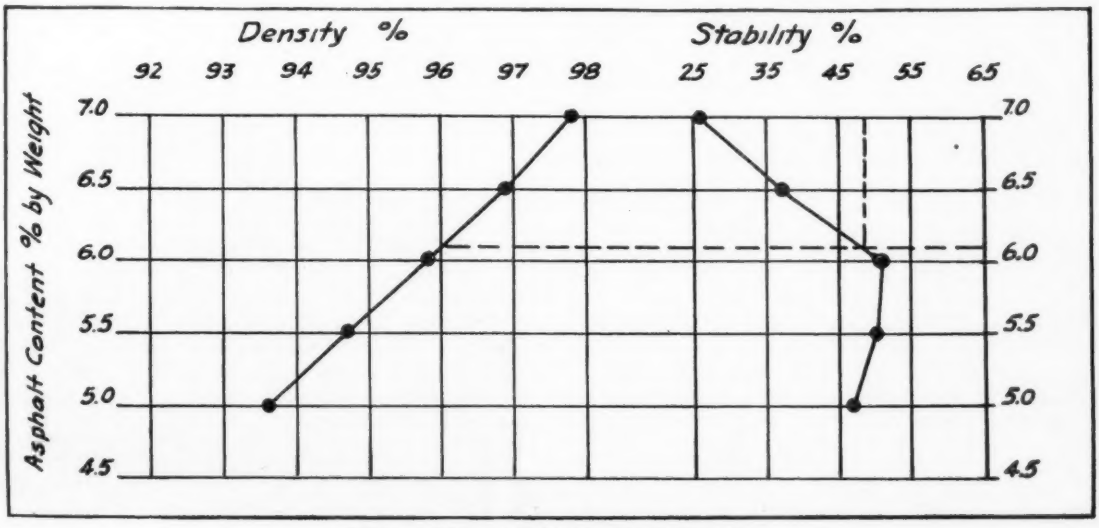
And assume the following aggregates available:

Table 2

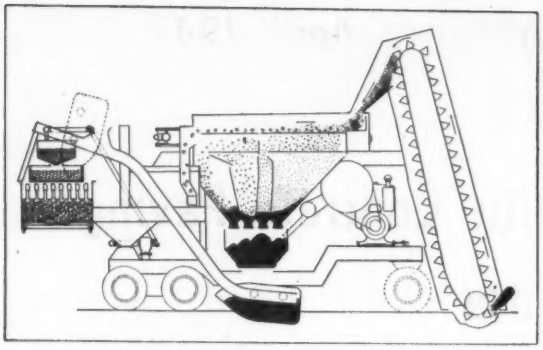
Size	Aggregate A % (large aggregate)	Aggregate B % (Screenings)	Aggregate C % (Sand)
⅝" to ½"	1.0	0.0	0.0
½" to ¼"	56.0	0.0	0.0
¼" to 10	41.0	1.8	0.0
10 to 40	1.0	54.7	0.5
40 to 80	0.5	17.5	50.2
80 to 200	0.5	12.0	45.8
Passing 200	0.0	14.0	3.5
	100.0%	100.0%	100.0%

Assume that Aggregate B is available in two-thirds of the quantity of Aggregate A, and the quantity of Aggregate C is unlimited. The specific gravities of these three aggregates are: A, 2.584; B, 2.554; C, 2.627.

Since A and B are available in the proportions of 3:2, the most economical proportioning would be a 60:40 combination of the two, but it is desirable to add a silica sand with material in the 40 to 200-mesh size. The specifications require 50 to 65% retained on the 10-mesh sieve; this material must come almost entirely from A and since the mid-point of the 50-65% range is about 57%, a trial may be made by using 57% of Aggregate A. To provide the fine



Density, stability and asphaltic content relationships.



How a mixing plant works.

material required, in addition to that provided by Aggregate B, about 8% of Aggregate C may be added to give around 4% for each of the groups 40-80 and 80-200 mesh. Since A comprises 57% and C 8%, B will constitute the remaining 35%.

The various components shown in Table 2 are therefore multiplied out by the appropriate percentages of A, B and C, and combined. For instance, in A, 56% is in the ½" to ¼" range, and 57% of this is 31.9%; in the same size range, none of the other aggregates can contribute; but in the ¼" to 10 mesh size, A will contribute 57% of 41%, or 23.4%, and B will contribute 35% of 1.8%, or 0.6%. The final combination will be as follows:

Table 3

Size	% in A	% in B	% in C	% in Combination
⅝" to ½"	0.6	0.0	0.0	0.6
½" to ¼"	31.9	0.0	0.0	31.9
¼" to 10	23.4	0.6	0.0	24.0
10 to 40	0.6	19.2	0.0	19.8
40 to 80	0.2	6.1	4.1	10.4
80 to 200	0.3	4.2	3.7	8.2
Passing 200	0.0	4.9	0.2	5.1
	57.0%	35.0%	8.0%	100.0%

It will be noted that the aggregates coarser than 10-mesh amount to 0.6 + 31.9 + 24.0 = 56% of the total and that the combined aggregate not only meets the specification quite well, but utilizes the available material about as well as is possible. The specific gravity for the combined mix is determined as 2.577. This will be used later.

The next step is the determination of the proportions of aggregate and asphalt. This is important for it affects the cost, the stability, the durability and the slipperiness of the finished pavement. In order to determine the best mixes, tests are necessary. Five different asphalt contents are normally tried out and tested for stability and density; usually three samples are made of each and the average of the values is used. To insure adequate grading control for these test mixes, the aggregates are segregated into various sizes and recombined. Specifications for asphalt content are 5% to 7%; tests are made at maximum, minimum, midpoint and quarter-point, that is, a 5, 5½, 6, 6½ and 7%. Mix No. 1 will be 5% of asphalt and 95% of the aggregate, and the others with greater percentage of asphalt. The quantities of each size of aggregate is determined by multiplying the percent of the various sizes shown in Table 3 by 95% for 5% asphalt content, by 94.5% for the 5.5% asphalt content, etc.

Assume that the following average values were obtained from the tests, using the aggregate combination shown in Table 3:

Table 4

Mix No.	% Asphalt Content	Specific Gravity Actual	Specific Gravity Theoretical	Density % Col. 4 ÷ 3	Stability %
1.....	5.0	2.241	2.394	93.6	47
2.....	5.5	2.251	2.377	94.7	50
3.....	6.0	2.262	2.361	95.8	51
4.....	6.5	2.269	2.344	96.8	39
5.....	7.0	2.272	2.328	97.8	26

In calculating the theoretical specific gravity, the actual specific gravity of the aggregates was used and the asphalt was assumed to have a specific gravity of 1.020 at 77°F.

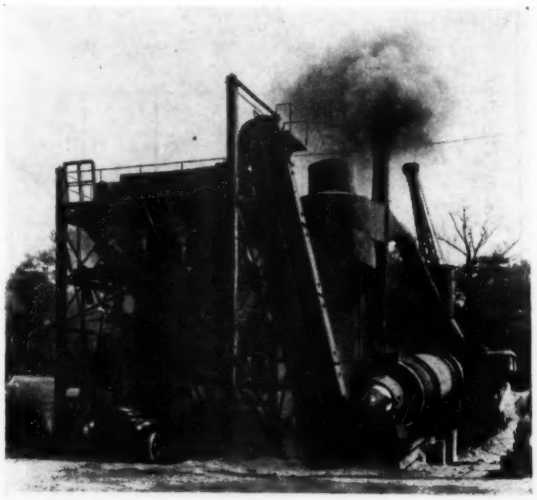
This design procedure is intended to produce mixes having densities of 93% to 98%. The asphalt required to produce lower or higher densities can be computed on the general basis that each 1% of asphalt will change the density about 2%. With cut-back asphalts, the residual asphalt content is used in estimating density changes. The density and stability required in Texas is:

	DENSITY			Stability %
	Min.	Max.	Optimum	Minimum
Cut-back asphaltic concrete..	94.0	96.0	95.0	35
Hot mix asphaltic concrete..	94.0	98.0	96.0	35

The per cent by weight of asphalt is plotted against the per cent density; and also against the stability, as shown in the accompanying graph. Since a hot-mix asphaltic concrete is being designed, the preferred density is 96.0%. Where the specimen density curve intersects the 96.0% density line, extend the line to the edge of the chart to determine the optimum asphalt content, which is shown to be 6.1%. Where this horizontal line intersects the stability curve, draw a vertical line to determine the stability, which in this case is 48.5%. In the event the chart indicates a stability less than 35%, the mixture must be redesigned. The mix will therefore consist of 6.1% by weight of asphalt and 93.9% by weight of each of the components indicated in the Combination column of Table 3.

In order to obtain the required proportions, aggregates A, B and C must be fed into the cold stone feeder in the relative proportions of 57%, 35% and 8% respectively. After passing through the drier the aggregate is screened into three sizes and stored in three bins (there may be more or less bins). Another

(Continued on page 35)



Hot-mix plant, with drier and elevator.

An English Experimental Sewage Treatment Installation

Details of a plant to treat about 60 gpm, which is adapted to a variety of methods of operation.

The experimental plant at Finham, Coventry, England, which includes four circular filters and four humus tanks, was constructed to provide information on different methods of operation of filters, which might be used in the main plant.

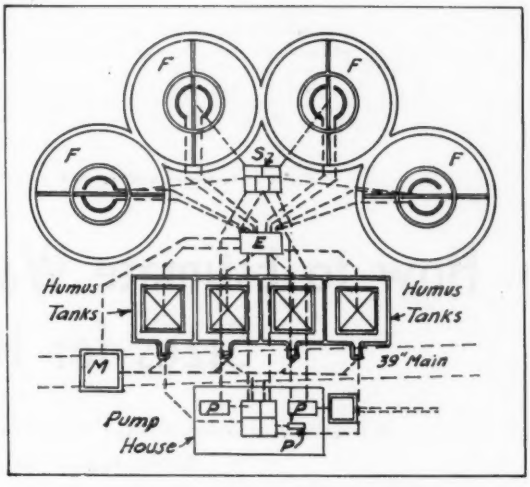
The four filters are similar in construction. Each contains 24 cubic yards of media and is divided by a vertical wall into two equal parts. The filter media is granite. Each filter contains at the bottom 1 ft. of 6-in. stone; above this in one-half is 5 ft. of ¾-in. medium and in the other half 2½ ft. of 1½-in. and 2½ ft. of 1-in. media. Each filter is operated as a whole but effluents from the two halves can be sampled separately. This gives an opportunity of observing the comparative resistance to clogging and the comparative purifying effect of fine and coarse media.

The two effluents from each filter unite at the inlet to an effluent-distributing chamber between the filter and its humus tank. From this chamber the effluent can be discharged without settlement to waste or to the pumps for return to any filter, or it can pass to the humus tanks. The effluent enters the humus tank through a central baffle-box and rises to overflow into peripheral weirs. The humus tanks have a nominal period of retention of four to five hours, at a rate of flow of 60 gallons per day per cubic yard and the rate of upward flow is about 2 ft. per hour. From these tanks settled effluent may be discharged to waste or it may be passed over telescopic weirs for measurement and return to the pump house. Sludge is removed from the humus tanks through inspection chambers by hydrostatic head.

In the pump house two of the three pumps can deliver filter effluent to any of the filters; the third pump supplies settled sewage to the filters.

This arrangement of the plant makes it possible to operate the filters at various rates and to supply to them any desired mixture of settled sewage and filter effluent. A wide range of experiments on biological filtration can thus be made, and there is adequate accommodation for the necessary laboratory work. Plant and laboratory have been constructed almost entirely from salvaged materials.

Through the winter of 1945 and the early months of 1946 the experimental filters were matured by operation at a low rate of flow. Experiments were begun in May, 1946, on three methods of operation. Filter 1 is treating settled sewage at an average rate of 60 gallons per cubic yard per day by single filtration. Filter 2 is treating settled sewage at an average rate of 120 g.y.d.; the sewage is diluted with an equal volume of returned effluent from the filter. Filters 3 and 4 are operating as alternating double filters at an average rate of 120 gallons per day per cubic yard in the two filters together; the order of filters 3 and 4 in series is changed daily. In operating this small experimental plant it is not possible to vary the flow of sewage to correspond exactly with the fluctuations in the flow to the main works. The flow to the experimental plant is therefore regulated so as to provide two different rates during a period of 24 hours—the lower rate being received from about 10 p.m. to 10 a.m., and the higher rate from about 10 a.m. to 10 p.m.



Layout of Finham experimental plant.
F, filters; S, Sewage distributing chamber; E, effluent distributing chamber; P, pumps; M, manhole.

The illustration and data are from *Municipal Engineering*.

DDT Residual Spray Effective in Malaria Control

DDT residual spray has been used for mosquito control in Breves, Marajo Island, Para, Brazil. Captain James D. Williams, Sn. Corps, who has been on the staff of the Institute of Inter-American Affairs, supervised the work which was, in effect, an experiment to determine the value of DDT residual in malaria control. Local swamps and other mosquito breeding areas were so large and numerous that control by oiling and drainage was not feasible.

Most of the houses in Breves are of wood, with a few of palm and some of tile and plaster painted with lime. Using a 5% DDT-kerosene solution, residual spray treatments were applied in May, July, September, November and December, 1945, and February, 1946. The amount of DDT applied is not recorded. Cost was $1 to $1.50 per house per application. All other control work, including medication, was stopped early in 1945.

It is probably too early to assess the value of the work but Captain Williams reports that, whereas there was a scarcity of labor due to malaria prevalence in 1943, the malaria rate is now at an all-time low. Adult *Anopheles (A. darlingi)* are so scarce that one can be found only rarely; and larvae have reached a "non-measurable" low density.

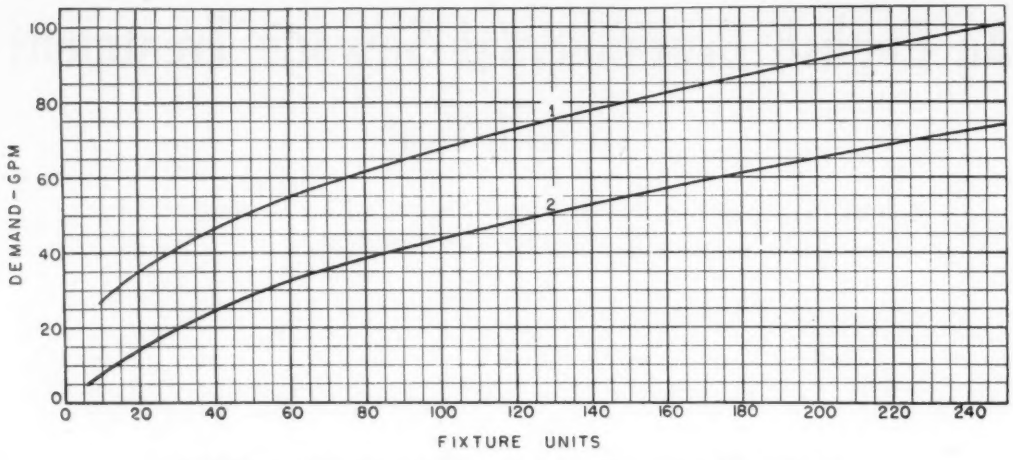


Fig. 2. Fixture units and demand; curve 1, flush valve units; curve 2, flush tank units.

How to Estimate Water Demands and Pipe Sizes for Housing Units

A method of estimating the water requirements for single and multiple buildings or for groups of buildings.

ONE of the problems involved in supplying water to groups of houses, apartment buildings and public buildings is the computation of the probable water demands. While it is necessary to supply enough water at all outlets that may be used at the same time, it is not necessary to provide for the maximum demand flow for all of them operating simultaneously. The following data, which are intended to provide wholly satisfactory service 99% of the time and reasonably satisfactory service all of the time, are based on probability of use, the frequently mutually exclusive use of two or more fixtures, and the time required for a fixture to operate.

In selecting pipe sizes, consideration must be given to loss of capacity in use. The amount of loss depends on the characteristics of the water and the pipe material used. It may result from corrosion and consequent roughening of the pipe, thus increasing resistance to flow; or to the formation of scale on the interior of the pipe with a consequent decrease in the useful diameter and its carrying capacity. Every water works engineer should be familiar with the conditions existing in his own community and should know what allowances to make for either case. The data on pipe sizes in this article are based on the use of new butt-welded steel or wrought iron pipe which may be classed as "fairly smooth" but is not so smooth as new copper or brass.

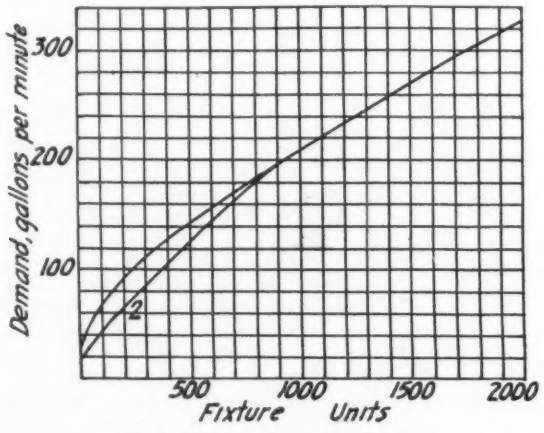


Fig. 1. Fixture units and gals. per min. Curve 2 is for flush tank fixtures.

Estimating the Water Demand

In order to estimate the flow of water that must be provided, it is necessary to know (1) the number of each type of plumbing fixture; (2) their grouping, as in bathroom groupings; and (3) their use, as public or private. To determine pipe sizes, it is necessary to know (1) piping layouts and lengths; (2) water main pressure; and (3) the elevation of the highest group of fixtures above the water main.

Number and Type of Fixtures.—Some fixtures use more water than others, and their location, the grouping with other units, and the type of service they are subjected to modify these use-characteristics. Experience and research have shown that certain weights can be assigned to each fixture for a particular condition of service, from which the probable demand, in gallons per minute, corresponding to any total number of fixtures, can be obtained. This demand represents the water use from these fixtures only and must be increased by anticipated usages for other purposes, such as air-conditioning and lawn sprinkling.

The weights that have been determined for the various fixtures are as follows:

Fixtures in Private Homes

Fixture	*Supply Control*	*Unit Weight*
Water closet	Flush valve	6
Water closet	Flush tank	3
Lavatory	Faucet	1
Bathtub	Faucet	2
Shower head	Mixing valve	2
Bathroom group	Flush valve for toilet	8
Bathroom group	Flush tank for toilet	6
Separate shower	Mixing valve	2
Kitchen sink	Faucet	2
Laundry trays (3 or less)	Faucet	3

Where both hot and cold water are available, total use will be as above; the maximum use for either one will be ¾ of that given.

Fixtures for Public Use

Fixture	*Supply Control*	*Unit Weight*
Water closet	Flush valve	10
Water closet	Flush tank	5
Pedestal urinal	Flush valve	10
Stall or wall urinal	Flush valve	5
Stall or wall urinal	Flush tank	3
Lavatory	Faucet	2
Bathtub	Faucet	4
Shower head	Mixing valve	4
Service sink (office)	Faucet	3
Restaurant or hotel kitchen sink	Faucet	4

Where both hot and cold water are available, the same rule applies as for fixtures in private homes.

These unit weights are converted to demand in gallons per minute by means of Fig. 1 or Fig 2, which is a portion of Fig. 1 on an enlarged scale. For instance, by Fig. 1, 1000 fixture units would represent a demand of 210 gallons per minute. In the case of a single home having 40 fixture units, with flush valves on the closets, the demand by Fig. 2 would be about 47 gpm.

Example.—(1). Assume a home having two bathrooms, a shower, a lavatory and closet separate, a kitchen sink and a 2-compartment laundry tray, with the closets all flush valve operated. The demand units are:

Two bathroom groups @ 8	16
One shower	2
One extra closet, with flush valve	6
One extra lavatory	1
One kitchen sink	2
One laundry tray	3
Total fixture units	30

By Fig. 2, curve 1, which is for flush-valve operated fixtures, the demand is 42 gpm.

(2) Assume a building containing 16 apartments, each of which has a bathroom group, with a flush-tank closet; a kitchen sink; and a 3-compartment laundry tray for each four apartments. The demand units are:

16 bathroom groups @ 6	96
16 kitchen sinks @ 2	32
4 laundry trays @ 3	12
Total fixture units	140

The demand, from Fig. 2, is approximately 53 gpm. If flush-valve closets were used instead, it will be noted that there would have been 172 fixture units, and the demand would have been about 85 gpm.

Other water uses must be added to the fixture demands determined as shown above. If the house in Example 1 has a ¾" hose connection, which has an estimated demand, under conditions of expected water pressure, of 8 gpm., the total demand will be 42 gpm + 8 gpm, or 50 gpm.

A certain pressure must be maintained at the highest fixture in order that it will operate satisfactorily. This pressure will vary with the specific type of fixture but will be assumed at 8 lbs. per sq. in. for purpose of illustration. The height of the highest fixture above the main must be considered, and also the pressure loss in the meter and in the pipe.

Figure 3 shows the pressure losses in water meters of ⅝" and larger sizes for flows up to 1000 gpm. If a meter that is too small is selected, the pressure loss will be excessive; if the meter is larger than is necessary, small flows may underregister, and initial and upkeep costs are increased.

Example.—(1). Assume a home in which the highest fixture is 20 feet above the main, and which has a demand of 20 gpm. Main pressure is 45 lbs. per sq. in., and it is assumed necessary to maintain a pressure at the highest fixture of 8 lbs. per sq. in. Pressure loss due to height is 20 x 0.434 or 8.7 lbs.; the residual pressure required is 8.0 lbs.; the remaining pressure is 45—(8.0 + 8.7) = 28.3 lbs. per sq. in. Fig. 3 indicates that a ⅝" meter would use up nearly all of this; that a ¾" meter would use a head of 9 lbs.; and that a 1" meter would use a little less than 4 lbs.

Assuming a 1" meter is used, the total loss of head would be 8.0 + 8.7 + 4.0 = 20.7 lbs. and the remaining pressure would be 45.0 — 20.7 = 24.3 lbs. Assuming a length of pipe from the main to the highest fixture of 120 ft., there would be available a loss of 100 (24.3 ÷ 120) or 20 lbs. per sq. in. per 100 ft. of pipe.

Fig. 4 shows the flow in fairly smooth pipes. A 1" pipe will deliver, according to this chart, about 26 gpm. with a friction loss of 20 lbs. per 100 ft. of length. If a ¾" meter were used, the loss would be 8.0 + 8.7 +9.0 or 25.7 lbs.; the residual pressure would be 45.0 — 25.7 or 19.3, and the available

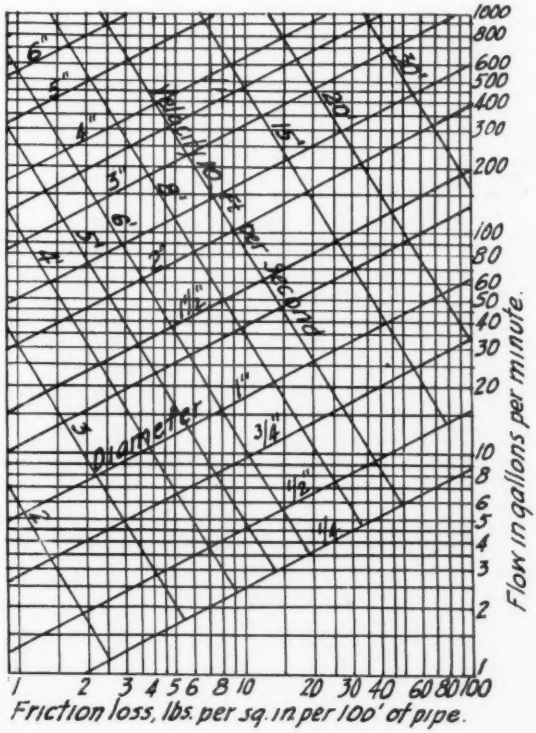


Fig. 4. Flow in fairly smooth pipes.

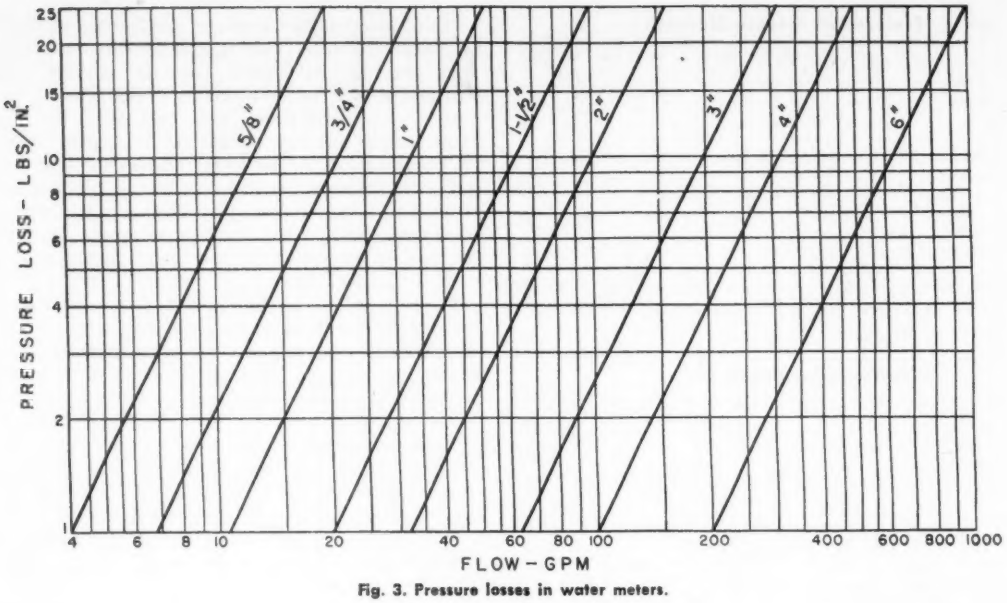


Fig. 3. Pressure losses in water meters.

friction loss would be 100 (19.3 ÷ 120) or 16 lbs. per sq. in., under which conditions the 1″ pipe would deliver slightly over 20 gpm. Since these computations are for new and fairly smooth pipe, any tendency toward pipe deterioration would result in an inadequate installation. Therefore, the 1″ meter and 1″ pipe seem preferable.

(2). Assume the 16-family apartment previously considered, which, equipped with flush-tank closets, has a demand of 53 gpm. To this may be added 2 hose connections at a possible 10 gpm each, making a total of 73 gpm. Assume further that the highest fixture is 25 ft. above the main; the length of pipe from the main to the most distant fixture is 250 ft.; the pressure in the main is 50 lbs. per sq. in.; and at least 8 lbs. pressure is necessary to operate the fixtures.

Fig. 3 indicates that for 75 gpm. a 2″ meter will probably have to be used, and that the pressure loss will be 5.5 lbs. per sq. in. Pressure loss due to height will be 25 x .434 or 10.8 lbs. per sq. in. The head available for pipe losses is therefore 50 — (5.5 + 10.8 + 8) or 25.7 lbs. per sq. in.; and this amounts to just about 10 lbs. per 100 ft. of pipe. Fig. 4 shows that a 2″ pipe will produce somewhat over 100 gpm., but that a 1½″ pipe will not be large enough, since it will carry less than 60 gpm.

This computation should be reviewed, using a 1½″ meter. On this, the pressure loss will be about 14 lbs. at 73 gpm., and the head available for pipe loss will be 6.9 ft. per 100. With a 2″ pipe, the delivery would be about 90 gpm., which is ample.

The same methods can be used to determine the sizes of the principal branches of the water distribution system inside the buildings. This is more often a matter for the architect or the plumber. However, the engineer may desire to check the design to be sure that it is balanced and that an adequate supply of water is provided. The location of the various plumbing fixtures must be known in order to compute branch sizes.

In areas where corrosion or scale reduces pipe capacity, ample allowance must be made for this. For instance, the 2-inch "fairly smooth" pipe in the preceding example will carry nearly 115 gpm.; a "rough" pipe under the same conditions will carry only 85 gpm.; and a "very rough" pipe about 68 gpm. In the absence of precise data, the pipe capacity shown in Fig. 4 may be decreased by 15% to allow for increase of roughness with age, though this will not be enough for more unfavorable conditions.

Acknowledgment.—The methods used in this article are based on Report BMS79 of the National Bureau of Standards, which was prepared by Roy B. Hunter and is a publication of the Department of Commerce. The charts and diagrams are from this report.

Methods of Assessing Property for Street Improvements

A committee report before the ARBA, on this subject, by James B. Wilson, Dir. of Public Works, Louisville, Ky., summarized methods in use by 73 cities. The following public works were paid for by assessment by the proportion of cities indicated: Street construction, 86%; sidewalks, 84%; grade separations, 11%; street maintenance, 7%; alley construction, 69%; fire hydrants, 10%; trunk sewers, 54%; lateral sewers, 78%. Special assessments are based on the following items:

Work	*% Cities Using*
Cost of work on property	12
Front foot value	30
Area of property benefited	21
Zones of benefits	14
Front foot and depth	16
Land value	4
Land and improvements value	3

Special assessment projects are initiated as follows: By petition of single property owner in 6% of the cities; by a specified percentage of property owners in 13%; by majority of property owners in 23%; by council or equivalent body in 27%; by council on petition of property owners in 25%; by other means in 6%.

The following costs are included: Preliminary field engineering by 57% of the cities; designing by 57%; construction engineering by 71%; advertising and letting expense, 68%; and street intersections by 47%.

SAVING PAVING

Improved technique for preparing and pouring joints in concrete pavement, as used by the Bureau of Yards and Docks, and reported in the USN, Civil Engineer Corps Bulletin.

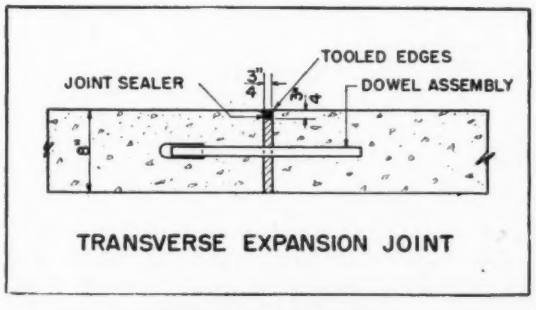
By COMMANDER ROBERT B. JENNINGS, CEC, USNR

THIS article describes the methods adopted at various installations of the Bureau of Yards & Docks for using rubber-base compounds for sealing pavement joints. These materials are covered by Federal Specifications SS-F-336, which prescribe the bond at low temperatures and the flow at high temperatures. In using this filler, due to the comparatively high melting point of the material and its very low heat conductivity a jacketed boiler was used to prevent burning of the filler by direct contact with heated metal. Temperatures of 450°F. did not affect the bonding properties of the filler, but its flow test rose from 0.5 cm. in 5 hours to 35 cm. in 2 hours, a rise of over 17 times which rendered it exceptionally sticky.

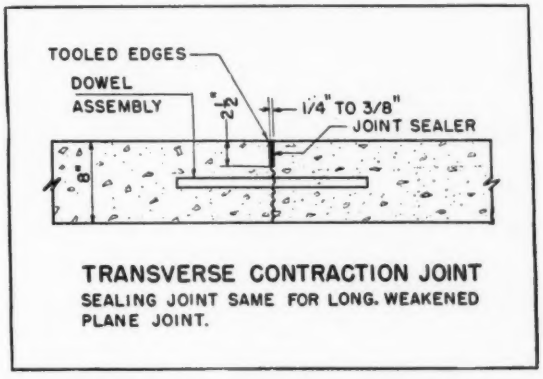
Since melting was exceedingly slow it was necessary to cut the filler into blocks of not over 10 pounds. Internal molecular tension made the substance too viscous for pouring into joints even with continuous paddle agitation during melting. This viscosity was overcome by placing the melted material in an ordinary oil-heated bituminous tank truck, fitted with a gear pump to supply the necessary agitation to break up the molecular tension. The tank truck's heating flues were lined with a metal sleeve to reduce the temperature of the melted compound. The pump was kept in continuous operation to maintain the viscosity at pouring point. This agitation resulted in formation of convection currents which reduced chances of overheating. A field laboratory was set up to make flow tests daily following the procedure in SS-F-336. Tests which indicate if there is deterioration from overheating are comparatively simple to make.

Improved processing and melting equipment have since been devised to handle the filler and the truck-mounted melting unit has been abandoned. The new equipment melts the material as required and any filler left in the reservoir can be reheated without changing its characteristics.

Cleaning the joints in runways and taxiways preparatory to pouring was accomplished by loosening accumulated dirt with hand tools, after which the joint was thoroughly blown out by compressed air.



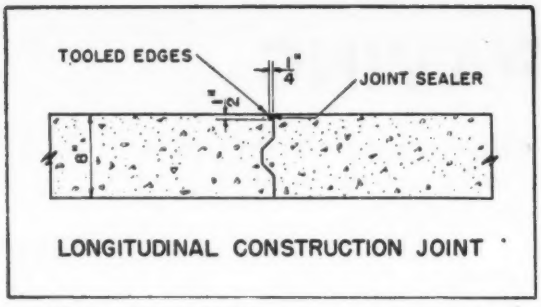
This joint has a shallow filler.



These are filled more deeply than expansion joints.

Joints were first poured by use of hand pouring pots. The contractor then tried a mechanical pouring kettle on wheels. The melted compound was pumped into a 50-gallon tank fitted with a tight, bolted cover and about 5 pounds of pressure applied. Because of the amount of the material, heat was applied to the pouring kettle. A discharge pipe extended from the tank to a rectangular pouring shoe about 5 inches long, 3 inches deep and 1½ to 2 inches wide. The shoe was placed over the joint, the discharge valve opened and the entire tank cart pushed along by hand. A suction line drew all the surplus material back into the tank, preventing overpouring, and the pressure on the tank stimulated the flow. This machine, though cumbersome, produced an evenly poured joint; however, about 3 or 4 miles of joint per day was the best progress that could be maintained. Inability to melt material fast enough was the most serious bottleneck.

However, the biggest step had been taken and it had been proved that joint seal of this type could be melted and poured without damage. There remained only the development of more practical equipment. First real progress was a single-tank truck incorporating all of the steps. This truck was equipped with an insulated hot gas mixing chamber. An oil torch discharged hot gas into the chamber where it was mixed with air until the desired temperature was reached. This hot mixture, controlled by dampers, was then circulated through the tank flues. By controlling temperature of this mix, overheating was eliminated. The pouring shoe was mounted on a swivel-jointed discharge line at the rear of the truck where a seat was provided for the operator. The truck was driven along joints at about 3 m.p.h. Circulation through a gear-type pump reduced internal tension and viscosity. An air compressor maintained 25 p.s.i on the discharge line and a blower delivered air into the mixing cham-



This type of joint used only on runways over 200 ft. wide.

ber and forced circulation through the flues. These attachments were driven by an auxiliary motor. This unit maintained a faster rate of progress and eliminated danger of overheating. Flow tests consistently indicated flows below 0.5 cm.

Sealing Materials

At present there are four or five different joint sealing compounds available on the market which are said to meet the bond and flow requirements of Federal Specification SS-F-336. All compounds developed to date contain some form of rubber. Some contain admixtures of Vermiculite, certain synthetic resins, asphalt, and other materials. Rubber, being somewhat compressible, will not extrude greatly on compression. When properly heated the exposed surface of the filler cools to a smooth, glazed surface which is not sticky nor will stones and sand adhere or settle into it.

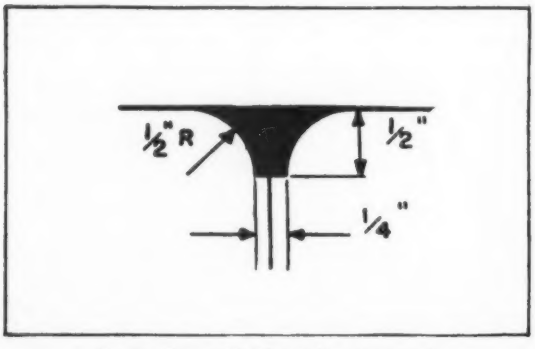
These seal materials are black and, hence, absorb solar heat at the maximum rate. Thought has been given to the advisability of either painting the exposed surface of the joints a light color or using a light colored pigment in the admixture so that summer softening can be reduced. Experimentation along these lines is considered justifiable.

Cold Weather Pouring

Comparatively little is known concerning the advantage of preheating concrete for cold weather pouring. Certainly the bond is adversely affected by pouring into very cold joints. Whether the effect is of sufficient consequence to justify preheating must be determined by experiments or experience. It is necessary that the joints be dry before pouring. If moisture is present, steam pockets, and bubbles will prevent proper bonding.

Where pavement requires resealing, some interesting special equipment has been developed for cleaning out the joints preparatory to repouring. A rubber-tired farm tractor has been adapted into a plow with a hinged frame carrying a pointed steel bar having a width to fit the joint. The frame may be lowered by a hand-operated hydraulic pump near the driver's seat. This plow will remove or loosen the bulk of old material in the joint. Under the tractor is a rapidly revolving wire brush to remove material loosened by the plow point. Further hand cleaning and blowing out with compressed air may be required. The most recent development incorporates a compressed air jet ahead of the pouring shoe. A street sweeper may be used to sweep the area along the sides of the joint, removing loose dirt which might blow into the joint before pouring.

It is not considered practical to remove all of the old jointing compound in preparing a joint for resealing. A small amount of the old asphalt or other seal in the joint is not believed to be seriously detrimental.



Details of area filled by sealing compound.

Advantages of Sludge as Fertilizer

In a discussion before the Institute of Sewage Purification (England) on the use of sewage sludge as a fertilizer, Sir Albert Howard said: "The heart of the matter was to be found in the nitrogen cycle in the soil, in which the nitrogen was transferred from the soil to the plant, from the plant to the animal, from the animal to the human being, and back again to the soil. If a crop was raised with chemical fertilizers and fed to an animal, one of Nature's great laws was transgressed. Use was then made of a bastard form of nitrogen such as sulphate of ammonia, which led to a bastard protein in the plant. Such a plant would soon lose quality, and its powers of resistance to disease and of reproduction would be impaired. In turn, that lack of quality, disease resistance and reproductive power would be passed on to the animal and to human beings. The effect of all this on ourselves was now fairly obvious. Parliament was discussing a scheme, costing £150,000,000 a year, for a national health service to deal with diseases, many of which need not have occurred at all, being caused largely by malnutrition resulting from poor quality food.

"Some of the speakers could not have studied the literature on this question, otherwise they would have discovered the true explanation of the results of the Rothamsted experiments on wheat. It had been stated in the discussion that wheat grown at Rothamsted with chemical fertilizers and wheat grown with farmyard manure showed no difference as regards vitamins and as regards quality. That might well be, but the speakers forgot one vital point which knocked the bottom out of Rothamsted, out of the policy of the Ministry of Agriculture, and out of the Agricultural Research Council. The seed sown on the Rothamsted plots was changed every year: the best seed that could be obtained was used for sowing, and a fresh start was made every year. Had the seed from each plot been used year after year for resowing that plot, it was certain that there would have been a rapid falling-off in the nutritional value as well as in the powers of reproduction of the crops grown with chemical manures.

"Another important point must not be forgotten. Sludge helped to provide the food necessary for the soil organisms, such as earthworms, moulds, microbes, and so on, whose waste products fed the plant. That was the real crux of the matter. It was essential in our farming and gardening that the earthworms and the microscopic life of the soil should be well looked after."

Electronic Coagulation

Something about a new method of coagulating water by the use of aluminum plates and electric current.

By FRED E. STUART, JR.

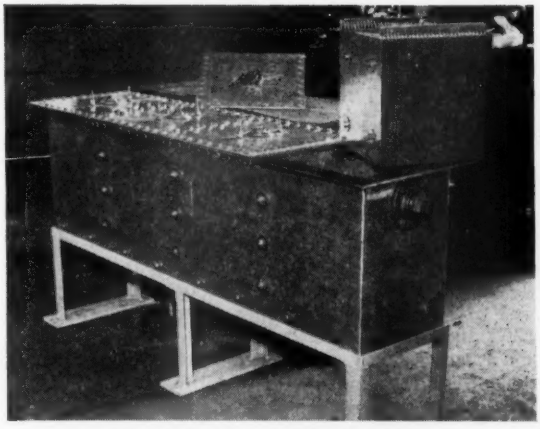
THE electronic coagulation principle provides a method by which alkaline or acid solutions containing concentrations of color-bearing materials may be coagulated under conditions requiring materially less control than are required by present methods. This method of coagulation utilizes the mass action of the surface area of sheet aluminum, increases the velocity of coagulation, and produces instantaneous floc formation electrically, without the employment of usual chemical coagulants.

Technically, the polyvalent ions of certain metals are more active in effecting coagulation than the monovalent ions, according to Hardy's rule of precipitation. The electronic water coagulation principle uses the power of the trivalent aluminum ion (Al^{+++}) for coagulation purposes, and electricity acts in the same manner as chemicals to form a floc. This is accomplished without the usual drop in pH value, which will be important, as the careful proportioning usually accompanying the use of chemicals is not necessary.

The working element of the electronic coagulator consists of a series of aluminum sheets spaced ⅛" apart. These are housed in a flow chamber in such a manner that all the water passing through is sliced into films ⅛" thick. These films of water are called "slices of solution." Opposite electrical charges are placed on alternate aluminum plates and the raw water passing through the cells acts as a conductor for the electrical current. The current carries trivalent aluminum ions from the aluminum sheets to the water. These ions form aluminum hydroxide, which is the floc that coagulates the water. The sheets are held apart by plexiglass spacers ⅛" thick, and the entire cell is insulated from the shell of the machine by plexiglass sheets. The electronic unit operates on a low voltage and high amperage d.c. current, obtained from a copper oxide rectifier or a motor generator set. An electronic coagulation unit presents 28,000 square inches of aluminum surface to 96 slices of water solution in each foot of coagulator area; that is, a unit containing 10 cubic feet would present 280,000 square inches of aluminum sheet area to 960 slices of solution. The one cubic foot cell will treat from 10 to 75 gallons per minute according to the degree of treatment for the different waters. In waters of high turbidities or color, the rate of flow is either slowed down, or the current stepped up to handle these increased impurities.

The electronic coagulator is a versatile unit. The cells are placed in a shell in parallel, with the number of cells varying according to the volume of water to be treated. The unit can be operated in a vertical or horizontal position, in series or in parallel, and can run open or under pressure. The floc formed can be emptied into the settling basin, preparatory to passage through sand filters, or it can be run directly to a pressure filter.

Two systems are now being used. One is to run the entire flow of water directly through the coagulator,



The electronic coagulation pilot plant.

and passing the water thence to the settling basins and the filters. This is the direct flow coagulation method, and all of the water to be coagulated passes through the coagulator. The second method utilizes the ability of the machine to form much more floc than is needed to coagulate the water actually passing through the machine. In this method, water is fed into the coagulator at a low rate of flow, and the current is stepped up to form an excess amount of aluminum gel. This treated water is then pumped into the main raw water line, where it combines with the raw water to form the floc. This method is called the slurry system of coagulation. The first method is generally used in smaller installations where the amount of water to be treated is not great, and the second system is used in large installations.

One of the characteristics of the electronic coagulator is the short time that the water to be coagulated must be in contact with the aluminum sheets. This time normally ranges from 15 to 45 seconds, during which time a suitable floc material will have been formed.

The electrical consumption of this device is low, but is influenced by the characteristics of the water. In some cases costs are as low as 70 cents per million gallons of water, but with very difficult waters recent field tests indicate costs may range as high as $18 per mgd.

The time of break-down of the plates was considered a major problem, because the first question that most people ask is "How fast do the plates wear out?" The answer to this question of course will depend on the nature of the water to be treated, the amount of current being used by the plates, and the method of treatment. The electronic coagulator uses from 4 to 12 lbs. of aluminum at a cost of 60 cents to $1.80 per million gallons of water. The one cubic foot cell weighs

(Continued on page 36)

An old-time bridge—and not too safe.

New Bridges Pay

How a County built 1438 new bridges and paid for them in ten years solely by savings in maintenance, without a bond issue.

BACK in 1938, Henry Cook, County Engineer of Tarrant County, Texas, decided to do something about the $50,000 to $55,000 that was being spent annually for the maintenance of bridges on the county road system. As a result, the county built 1,438 new bridges, principally of concrete. Now nine years later, the entire cost of this construction has been repaid out of annual bridge maintenance savings, except for $41,000, which will be paid in 1948. Tarrant County is not worrying over loose floor boards or the high cost of lumber. Its bridges stood up under war-time traffic and today are essential factors in a broad plan for a better county road system. Design was so sound and forward-looking that there will be no bridge problem in this Texas county for many years to come. And this was accomplished without a bond issue; time warrants, with repayment out of annual maintenance savings, financed the program. The 1947 payment of $46,000 leaves only $41,000 to be paid. The 1946 statement of the County Auditor shows less than $1,400 was spent for bridge costs in 1946.

The planning and construction of these bridges were described in the May, 1940, issue of PUBLIC WORKS. Since that time Mr. Cook has had three years of Navy service, and is now back at his post in the County Court House at Fort Worth.

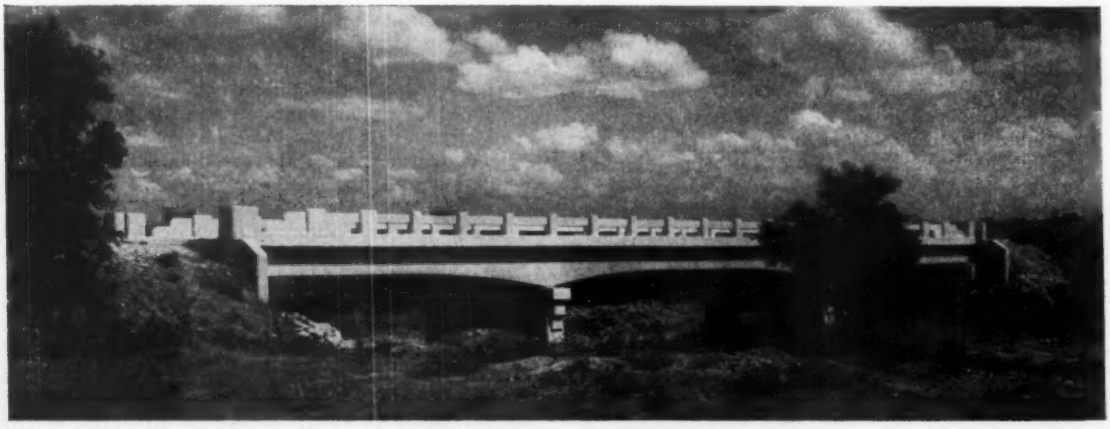
Maintenance of Old Bridges Not Economical

Impetus for the program came from the heavy annual maintenance costs for the inadequate bridges that were relics of the horse and buggy days. Many of them were too narrow to accommodate two-way traffic; guard rails had fallen or been knocked off by traffic, or had never existed; many bridges were deficient in strength; alignment and approaches were often dangerous; foundations were so poor that some bridges had settled and had been repaired by constructing another bridge on top of the old one.

Basis for the program was cooperation with the Works Progress Administration. The county contributed $483,000 and the WPA made available labor and materials about three times as great in value. A field survey was made of all bridges on the county system, and a report was prepared on each, describing the existing structure and stating if replacement were necessary. From these data, the general program was worked up and an estimate of the cost made and broken down into labor, equipment and materials. These costs indicated that the county could finance its share of the program from savings in bridge maintenance, which has since been borne out by experience. Engineering surveys were made for each structure, including traverses of drainage areas and cross-sections of stream channels and adjacent highways. From these surveys, plans were prepared.

Mass Production Methods

Construction was based on mass production methods. A central construction yard was located on a 50-acre tract owned by the county, which was near the center of the county and was served by a railroad siding for material delivery. Facilities were provided for equipment repairs and servicing. One section of the yard was devoted to form-building. The foreman of this section was furnished plans for each structure and the approximate date that forms would be needed. Forms were built and tagged for each individual bridge. After being used, these were returned to the yard,



One of the modern-type bridges built in Tarrant County.

Pay Themselves in Ten Years in Reduced Maintenance Costs

cleaned, oiled and re-used or modified for use on another structure. Form lumber was purchased in large amounts at a substantial saving.

Steel also was purchased at a low price, in 60-ft. stock lengths. Plans for each structure were channeled to the steel fabrication section, where the steel was cut and bent, and then tagged for delivery as needed. Approximately six million pounds of steel were used in the program, all of which was fabricated by crews employed on the project.

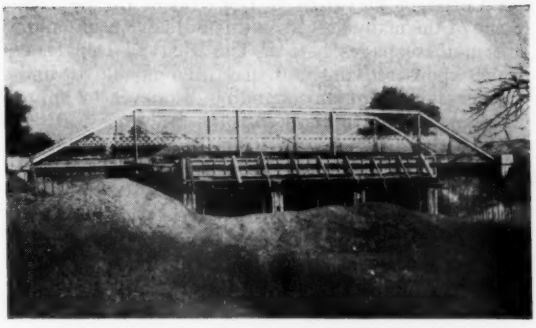
Two gravel deposits, with washing and screening plants, were leased on a royalty basis from local sand and gravel companies. These plants were manned by employees assigned to this project and all material was produced by them.

New equipment was necessary to handle the work, and the county purchased 28 new motor trucks, 4 new concrete mixers, electric saws for form making, equipment for steel-bending, water storage tanks, concrete buggies, wheelbarrows and many small tools. This was supplemented by other equipment already owned by the county.

Cost of Program

Careful cost data were kept on every project, including materials used, labor, and such other data as were pertinent. Each structure was located and numbered, a brass plate being provided which was set in the headwall of each bridge. On this plate was stamped the bridge number, for instance, 2012-10, indicating bridge No. 10 on road 2012. Space was also provided for stamping bench-mark data. All concrete work was carried on under the control of an independent testing laboratory.

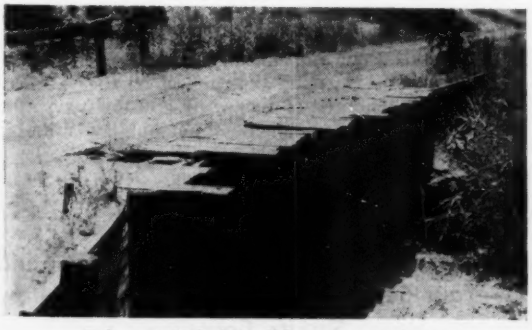
The cost of this program would now probably amount to several times more than it cost ten years ago, but the principles are just as applicable now as they were then. First, is the necessity for an inventory to determine what is on hand and what is needed; second, is a comprehensive plan to provide for the present and long-range needs; third, is an analysis of present costs for maintenance and repair; fourth, is a study of possible sources of assistance, for even though WPA is no longer with us, there are still other resources; fifth, is a plan for the organization to do the job, combining economy of construction with low maintenance and structures of long life.



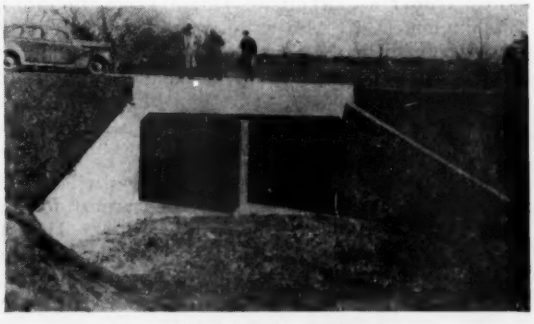
An outdated steel bridge is strengthened.

Typical of the larger spans.

This article was prepared by the same member of PUBLIC WORKS *editorial staff that prepared the original article seven years ago. In the course of its preparation, many of the bridges were inspected. We are indebted to Mr. Cook and other county officers for making available the records and data on which this article is based.*



Before: Typical of the old wooden structures.



After: A modern culvert

A Health Service for the Armed Forces

By W. A. HARDENBERGH

AT THE present time, all of the non-medical sciences are fighting to prevent passage by Congress of HR 1982, which provides for a Medical Service Corps in the Medical Department of the Army. Some of the many defects in this bill have been brought out in these pages before. The Medical Department, which sponsored this bill, has been unable to find a single scientist of any standing whatever to approve its plan; there are many regular army medical corps officers who disagree with it, but they do not dare say so; and it has no support from any recognized health agency or department. Nevertheless, the Medical Department has managed to cloud the real issues before Congress by making compromises which are shadow and not substance; by promises, incapable of fulfillment and often contradictory, to various groups; by making statements of personal intent to do this or that, when these should be inherent in the bill and not dependent on the whim of any one individual; and by exhibiting a paper administrative setup that may look fairly good but to anyone with military administrative experience is clearly unworkable.

The implications of this bill go much farther than most people realize. In addition to insuring a second-rate scientific organization for the army, through its unsound and unworkable provisions, its discrimination in promotion, and its inability to attract any good men, it will affect reserve officer promotion. With limitations on the promotion of sanitary engineering and other scientific regular army officers, the reserve officer can expect very little indeed. It may affect the status of the non-medical personnel in the Public Health Service, which in the past has taken its cue from the army regarding rate of promotion. It will certainly affect eventually the relative status and the pay of every non-medical man engaged in health work. Sanitary engineers will be the principal sufferers because they are generally the best paid of the non-medical groups.

Many pages could be written on the background of this bill, much of which would bring no credit at all to the fairness, foresight or understanding of medical corps officers. But that is beside the point. The important thing in respect to this bill is to defeat it. Write your Congressman fully, expressing your opposition to it and send a copy of the letter to Representative Walter G. Andrews, House Office Building, Washington, D. C. Also write your Senator opposing any similar bill in the Senate and send a copy of your letter to Senator Chan Gurney, Senate Office Building, Washington, D. C.

A Plan for the Future

There is every indication that Congress will direct or authorize the merger of all of our armed forces. This unified service should have a Military Health Service to protect the health of its personnel anywhere in the world that our forces may have to go. This health service should be wholly separate from the medical service which cares for the sick and the wounded, provides hospitalization, and is responsible for medical supply. It should be truly a health service, with representatives from all of the preventive sciences. It should perform for the armed services essentially those functions that the Public Health Service should provide for our civilian citizens. Doing this is no longer a job for the individual medical officer, usually untrained in health protection, to perform between caring for the sick and the wounded; it is no job to assign to the obstetrical specialist, as was so often done in World War II because there was no other place where he fitted either; it is a job for public health specialists of the broadest character and ability.

Such an organization, by using many non-medical specialists, would reduce the demand for doctors, a matter of sore importance in the past war and likely to be still more important in the future. It would permit coordination in joint operations of health protection work, a thing sadly lacking in many areas of joint operations in World War II. Methods were different, ideas were different, supplies were different; though personnel were made available by the Sanitary Corps to any organization that needed them, there was little cooperation and overall results too often were not very good.

This proposal will meet with the solid opposition of the old-time upper-level medical officers, most of whom came up to their present grade through the wards of army and navy hospitals. It will be welcomed by many of the younger officers who were engaged in health work for the army or navy during the war, but they will not be allowed to speak. But health protection should no longer be the step-child of the army and the navy and subject to the mental limitations, training and viewpoints of the curative doctor.

The Senate Armed Services Committee, which is now studying the unification program, would do well to ask a small group of outstanding public health administrators to formulate a general program and an organization for consideration. Such a group should represent both medical and non-medical public health groups, as sanitary engineering, entomology, and laboratory sciences; and should include some men who, by virtue of administrative positions in the public health organizations of the army or navy during the war, are familiar with military problems, army and navy organization, and military administration.

None of this is intended to reflect on the excellent medical care rendered by the Army and the Navy; but skill in curative medicine does not qualify a doctor to be a public health expert.

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Don't Forget to Write Your Congressman and Your Senator Opposing the Medical Service Corps.

Public Works Engineering Methods and Data

Cost of Water Pipe Trenching and Backfilling, 1946

By Charles R. Moore
Assistant Engineer, Portland, Me., Water District

Cost data on water extensions during 1946 for the Portland, Maine, Water District, were summarized in a paper (by Mr. Moore) before the Maine Water Utilities Association. These data cover 9,136 ft. of 2-inch to 8-inch pipe, but include only costs of trenching and backfilling.

Hand labor was used on 3,634 ft., on which the average cost was 96.8 cents per foot, with a high of $1.49 and a low of 60 cents. Machine trenching was used on 5,502 ft. on which the average price was 74.8 cents per foot, the high price $1.05 per foot, and the low 45 cents.

The work comprised 35 jobs, ranging in length from a minimum of 60 ft. to a maximum of 815 ft. Most of the machine ditching was done with the District's Barber-Greene trencher, but a back hoe, a rotary trencher and a tractor mounted shovel were also used. There was no ledge or rock job included in this tabulation.

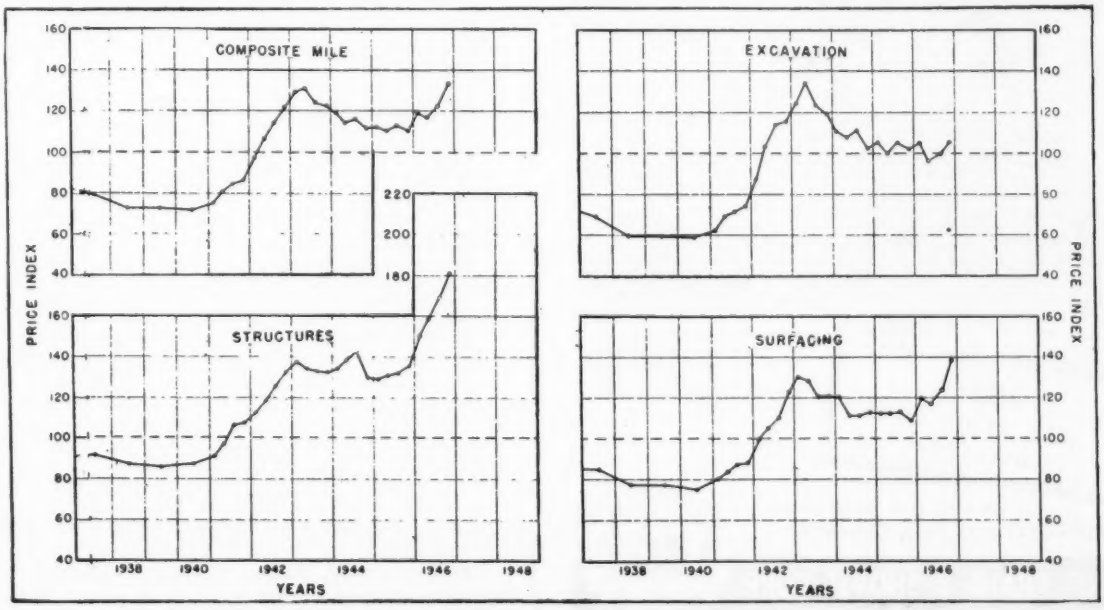
Price Trends in Highway Construction

Highway construction costs rose sharply in the last quarter of 1946, as indicated on the accompanying chart which was prepared by the Public Roads Administration. Common excavation remained about stationary; concrete pavement rose from $2.66 per square yard in the first quarter of 1946 to $3.08 in the last quarter. Structural concrete prices averaged $42.86 per cubic yard in the last quarter, as compared to $35.44 in the first quarter and a 1946 average of $38.79. Excavation cost only slightly more than it did in the base period of 1925-29; concrete pavement in 1946 cost 25% more and concrete structures 65% more.

In December the U. S. average hourly wage rate for executive, administrative and supervisory personnel was $1.53, varying from $1.99 in the Pacific States to $1.31 in the West South Central States; the U. S. rate for skilled labor averaged $1.62, with a high of $1.92 in the Middle Atlantic States to $1.35 in the South Atlantic; for intermediate labor, the U. S. average was $1.16, with a low of $1.00 and a high of $1.45; for unskilled labor, the U. S. average was $0.83 ranging from $0.67 to $1.25. These figures cover work on Federal Aid Projects and are reported by the Public Roads Administration.

Irrigation with Strawboard Waste

In a recent bulletin, the National Council for Stream Improvements refers to a mimeographed report by John Loughlin stating that two strawboard mills in Australia are disposing of their effluent by employing it for irrigation of agricultural land. A farmer operating a 250-acre dairy farm adjacent to one of the mills used a single furrow hill plough to construct a system of irrigation channels on his property and equipped them with control gates. The mill effluent was first settled, then distributed to the pastures through the irrigation system. Between one-quarter and one-half a million gallons of waste containing 6,000 p.p.m. of dissolved solids and 600 p.p.m. of lime (CaO) was disposed of daily in this manner. The farmer claims vast



Price trends in highway construction for past 10 years.

UNIT SHOVEL
Crawler-type excavator. Low center of gravity for greater stability. Handles easily. Low cost. Low upkeep.

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improvement in the fertility of his land resulting from several years of this practice, the carrying capacity of the pastures having been increased from 40 to 500 cows.

Effluent from the other mill is used to irrigate a large acreage utilized for growing flax. No claims are made in regard to beneficial effects on the crop other than that obtained by use of the water. However, no detrimental effects of the chemicals present in the waste were noted. Both mills cook cereal straw primarily with lime and the effluents are not caustic.

It would be interesting to know the character and chemical composition of the soil of the dairy farm before and after irrigation with mill waste. The tremendous productivity reported exceeds that of best pasture lands in this country and would be hard to explain on the basis of humus, K, P, N, or lime additions made to the soil by the waste even if such constituents were deficient to begin with. However, the water alone can be of great value in dry climates such as found in parts of Australia and the observation that the constituents of the waste were not detrimental is of importance. It is possible that this waste contains growth promoting compounds or that the method of its application led to optimum utilization of its beneficial components.

Cost of Common Maintenance Operation

The present cost of the common maintenance operations, as reported by several States, is: $6.92 per sq. yd. for concrete patching of concrete pavements; $0.10 per sq. yd. for light bituminous surface treatments; $0.21 per sq. yd. for a 75-lb., mixed-in-place, bituminous surface treatment; and $0.76 per sq. yd. for a heavy (200-lb.) bituminous surface course.

Reports indicate that two new methods of performing maintenance operations, mechanical joint and crack filling and mechanical loading in conjunction with ditch cleaning, reduce the cost of these particular operations by approximately 50 percent.—*Committee Report, J. S. Bright, Chm., Highway Research Board.*

Public Use of Reservoirs—An English View

In deciding for any particular case what public uses of reservoir lands and waters may be justified the following criteria may be considered:

1. The public use must be consistent with the economical production of a safe and satisfactory water supply. Where water supplies are unfiltered, public use generally should be restricted, if not completely prohibited. Where supplies are filtered, a much more liberal policy may be followed, and often many desirable recreational and educational uses permitted.

2. All public use of reservoir lands and waters which is permitted should be such as to result in a definite community benefit.

3. If consistent with other limiting factors, public use of reservoir lands and waters quite properly may be permitted as a means of improving the relations of the water utility with the public.

4. The cost to the utility of extending and controlling worthwhile public use of reservoir lands and waters must be commensurate with the benefits accruing to the utility. The prime function of the water works is to supply water and not to extend community service.

As an example, Staines U.D.C. have been granted permission to use, rent free, as an open space, an area of approximately five acres of land at the north-

west corner of the Staines West Reservoir of the Metropolitan Water Board.

Prior to 1939, it was the practice to permit fishing in certain of the Metropolitan Water Board's reservoirs and channels. For security reasons these facilities were withdrawn during the war, but upon the cessation of hostilities the matter was reviewed and the Board agreed to allow the resumption of fishing during the season 1946-47.

Certain angling societies have been granted fishing rights and members of the public are to be granted permission to fish in selected reservoirs on payment of one shilling for day tickets or one guinea for season tickets.—*London Contractors Record.*

Preventing Ice Ruts in Passaic

By ANTHONY MARTINI

Superintendent of Streets, Passaic, New Jersey

A FEW winters ago Passaic motorists had to inch along over streets filled with ice ruts that were often several inches deep. To make it worse for them these streets were generally east-west thoroughfares with heavy traffic. They rarely got sun during the winter, and as a result after bad storms, the snow was likely to pack and freeze before the city could remove it. Not only were bus schedules thrown off considerably but no matter how slowly a bus went, passengers took a severe bouncing.

When a street froze like that, the only way we could clear it was to rope it off and go in with picks and air compressors to cut through the ice and haul it away. By the time the clean-up squads had finished, we had traffic jams on our other arteries. It took time and it took money. We used to spend from $8,000 to $10,000

Passaic spreads salt during snow-storm.

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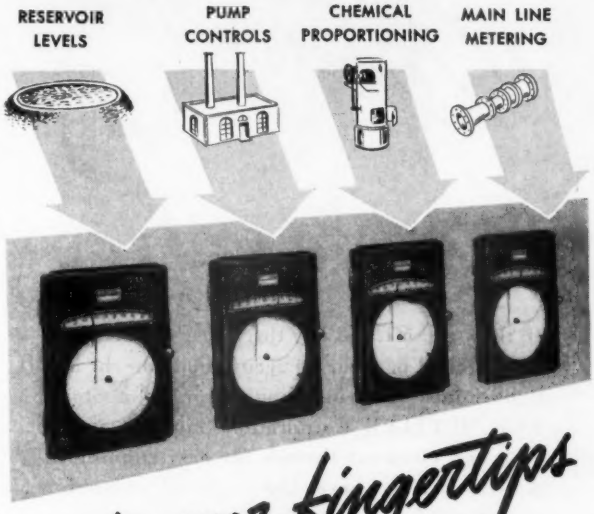

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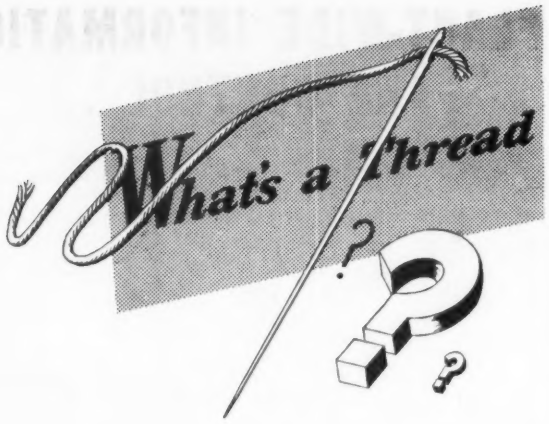

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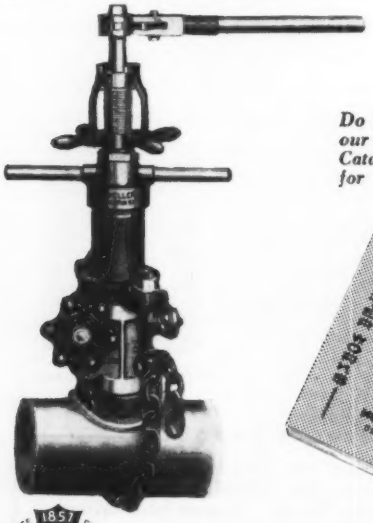

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a season on ice-rut removal alone, exclusive of regular snow removal costs.

In recent years, to give drivers, passengers and pedestrians a better break we decided to use rock salt for snow and ice removal because we found it would prevent such ice formations, making our pick and air-compressor squads unnecessary, and would save time and effort besides. We spread rock salt as soon as it begins to snow or sleet, and we find that it prevents snow from bonding to the pavement and forming ice. In a light fall, the salt may melt the snow so we don't have to send out the plows. During freezing rains it keeps an ice film from forming.

Before a storm hits, we check the Weather Bureau reports in Passaic and near-by cities, and, when the storm flash comes through, our two salt spreaders, loaded and ready to go, move out and distribute salt evenly on all main business thoroughfares. Even when the temperature drops to freezing or below, this treatment is effective in keeping the snow from freezing so that our 19 plows and 2 snow loaders can work efficiently. In the territory which we serve we try now to practice snow and ice prevention rather than just removal. It pays off in better service for our motorists and less work for us—no more hand work to get the ice off.

Another fact we discovered in using rock salt is that the small amount of it remaining on streets after one storm will keep snow from bonding to the pavement when the next snowfall hits and give some protection to traffic until our equipment can reach all of the streets.

Testing an Auxiliary Engine for a Pumping Plant

The Concord, N. H., water department, of which P. R. Sanders is superintendent, installed an auxiliary pumping unit in the water department in 1945. This is a single stage, double suction (10" suction, 8" discharge) Morris centrifugal, driven by a Sterling 6-cylinder, 132-hp. gasoline engine. This installation was tested, the discharge being measured through a Venturi meter and the gasoline consumption by the hourly decrease in level in the fuel tank.

At 128.5 ft. head, the unit pumped 2630 gpm. against a guarantee of 2590 gpm. The gasoline consumption was 10.2 gals. per hr., 64.7 gals. per mg., or 0.503 gal. per million gallons raised 1 ft.; 15,400 gals., of water were pumped per gallon of gasoline.

Cost of Sewers Built in 1945 in Newton, Mass.

The report of the Engineering Department of Newton, Mass., for the year ending Dec. 31, 1945, which has just been received, lists 5,542.8 ft. of 8-in. sewer built during the year. This work involved 15 separate projects, ranging in length from 99.8 ft. to 795.5 ft., with 50 manholes. The total cost was $41,824.19, or $7.55 per ft. of sewer. The per foot cost of the individual jobs varied from $3.90 to $13.58.

Pozzolith for Concrete Pavement Construction

The Mississippi State Highway Department tries out new methods and materials on experimental sections of their highways. On a 3-mile section of the Starkville-Columbus Road, three-quarters of a mile will be paved with concrete to which pozzolith has been added to give a better dispersion of water and cement,

and improve the workability with a low water-cement ratio. On this same project, 4-inch expansion joints spaced 400 ft. apart will be tried.

Unit Prices on Minnesota Highway Bids

Beginning early in 1946, the Minnesota Highway Department held a number of lettings. The bids received and unit prices quoted at each letting were used as a guide in selecting projects for following lettings. Unit prices on grading and concrete paving averaged approximately 40 per cent higher than in 1940, on bituminous surfacing about 30 to 35 per cent higher, while prices on monolithic concrete culverts advanced nearly 130 per cent. Bridges on which bids were taken were not sufficient to furnish any adequate index of steel bridge prices except to confirm the previous belief that construction of bridges requiring any substantial amount of steel would be out of question in 1946. As a result of the experience in the early lettings, it was decided to advance the letting dates on a number of contemplated bituminous surfacing projects and to postpone bridge projects and those grading projects in which the number of required bridges and culverts was a major factor in the total cost.

A study of the prospective availability of material, labor and equipment made it apparent that the Department would not be likely to receive any favorable bids early in 1946 on any project where a major part of the work must be carried over into 1947. This situation changed somewhat as the season progressed. The Department, accordingly, continued taking bids on a limited number of projects during the late summer and early fall, mostly on projects which could be substantially started during the 1946 construction season, or projects of more than ordinary urgency.

Designing Asphaltic Concrete Mixtures

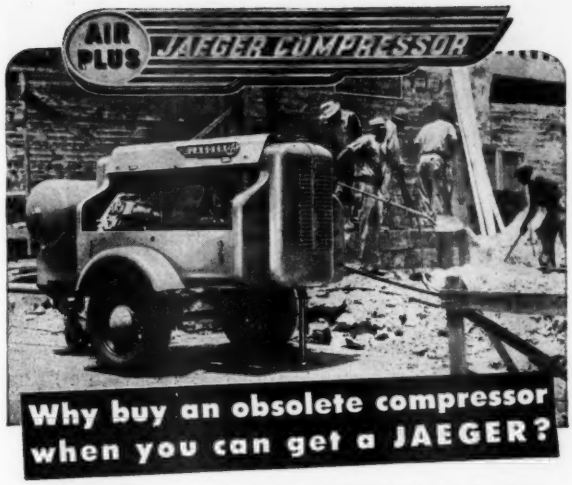
(Continued from page 20)

computation must be made to determine the specific amounts to be passed to the mixer from each bin, so that the desired final mixture will be obtained. As a first step, screen tests must be made to determine the composition of aggregates in each bin. Assume that these tests indicate the following from each bin:

Table 3

Size	Bin No. 1 %	Bin No. 2 %	Bin No. 3 %
⅝" to ½"	—	—	3.1
½" to ¼"	—	33.5	96.9
¼" to 10	—	61.7	—
10 to 40	45.5	2.2	—
40 to 80	23.9	1.1	—
80 to 200	18.9	0.9	—
Passing 200	11.7	0.6	—
	100.0%	100.0%	100.0%

As stated above, aggregates amount to 93.9% of the final mixture. Hence the numbers in the "Combination" column of Table 3, representing the relative proportions of each size of aggregate, must be multiplied by 93.9% to determine the percentage of these aggregates in the final mixture. For example, ¼" to 10 mesh amounts to 24% of the aggregate, or 24% x 93.9% = 22.5% of the final mixture. All of this size aggregate will come from Bin 2, Table 5, which will therefore contribute 22.5% ÷ 61.7% or 36.5% of the total. The ½" — ¼" aggregate in Bin #2,



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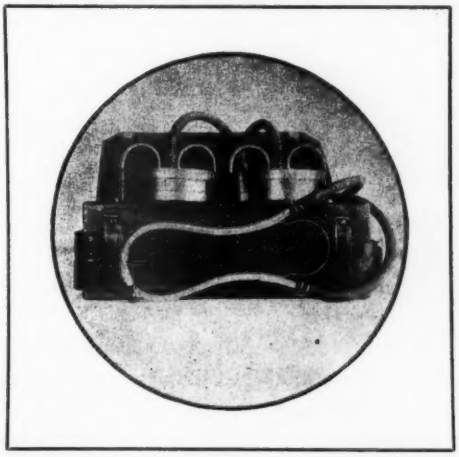

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on the same basis, will be 33.5% x 36.5% or 12.2% of the total. Since the design calls for 30% of this size aggregate (31.9% as indicated in Table 3 multiplied by 93.9%, or 30%), the remainder, 30.0 — 12.2 or 17.8% must be supplied by Bin #3. Therefore, Bin #3 will contribute 17.8% ÷ 96.9% or 18.4% of the total. Bin #1 will supply the remainder of the aggregate, that is 93.9 — (36.5 + 18.4) = 39%.

These computations can be started using any size aggregate which is found in a single bin, such as the 5/8" to 1/2" size in Bin #3, but it is preferable and generally more accurate to base the computations on a size that represents a greater percentage of the total.

Each of the fractions in Table 5 are multiplied by the appropriate percentage of 39.0 for Bin 1, 36.5 for Bin 2 and 18.4 for Bin 3, the various fractions added together horizontally to produce the combined analysis for each screen size, and these are checked against the design mixture. Usually these will not agree precisely, but unless they are not within the designs limits, it is not necessary to recompute them.

For a batch of 2000 pounds, the batch weights will be as follows:

Bin No. 1.....	39.0% of 2000 lbs.	780 pounds
Bin No. 2.....	36.5% of 2000 lbs.	730 pounds
Bin No. 3.....	18.4% of 2000 lbs.	368 pounds
Asphalt	6.1% of 2000 lbs.	122 pounds
	100.0%	2000 pounds

Frequent tests will be necessary to insure that the aggregates do not change in grading and that the plant is producing a mixture meeting design standards.

As previously indicated the procedures described in this article are based on Texas State Highway Department methods. They are intended to illustrate the principles used in proportioning mixtures. Favorable aggregate compositions have been employed to avoid an unnecessarily lengthy article.

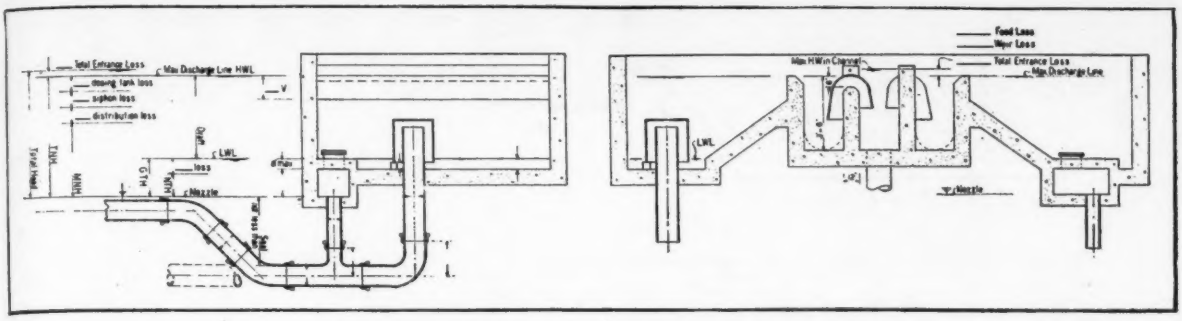
Electronic Coagulation

(Continued from page 27)

43 to 45 lbs., so the life of the unit would be between 3 and 4 months at a low rate of flow. The units are interchangeable and can be replaced by one person in less than an hour, using no special tools.

The mineral content of the raw water unites with some of the aluminum ions from the aluminum plates, while the remainder forms an aluminum compound which removes organic color from the water. These aluminum compounds can be flocculated and removed without the necessity of lowering the pH value.

After various tests in different sections of the country, it can be said that the electronic principle of coagulation yields a higher degree of clarification and a faster floc formation than has generally been attained with routine chemical coagulants. The electronic coagulator does not require the same size basins as do the chemical mixing units used in present-day practice, as the electronic floc is much tougher, even passing through flash mixers without breaking up and going back into solution. The floc settles quickly and does not require careful treatment, therefore, small settling basins can be utilized. Another advantage of this type of coagulation is the fact that low alkaline, highly colored water can be coagulated for color removal while the pH value can be increased at the same time.



Twin dosing tank sections for spray nozzles, showing various losses.

TRICKLING FILTERS

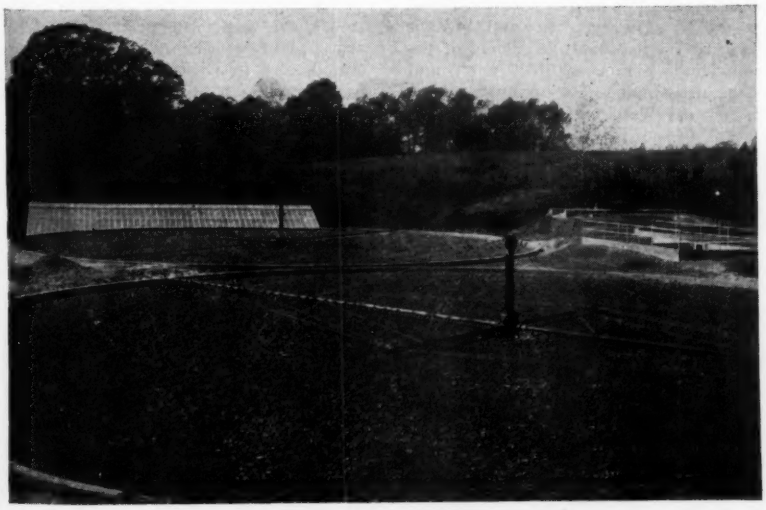
By the Editors of Public Works Magazine and Consultant Staff

R. S. Rankin, B. A. Poole, F. H. Waring, H. M. Bosch, L. L. Langford, C. W. Klassen, Ray E. Lawrence, S. L. Tolman and J. J. Gilbert

Low rate trickling filters; description; loading; results of treatment; design procedures; distribution equipment; computing head losses.

THIS classification consists of the conventional trickling filter variously termed "low-rate," "standard-rate" and, by the NRC Subcommittee, "deep filters without recirculation." In this series of articles the term "low-rate" filters will be used. Generally these filters are 6 to 8 or 9 ft. deep. The upper limit of volume loading is usually around 600,000 gallons per af. per day. The organic loading varies and is normally about 400 lbs./af. of BOD, but may be higher. Each state has requirements which must be followed for BOD or volume loadings. [Ohio has set 0.33 lb./cy. of BOD, or 538 lbs./af., as the upper limit of loading on this type of filter. Operating results generally confirm this figure. Plants having milk wastes, peak loads from which come in late spring and early summer, deter from going to higher loading. FHW.]

This type of secondary treatment when properly designed and operated will produce a good effluent; it will withstand considerable overloading without serious deterioration of the effluent, and is effective in treating many types of industrial wastes.

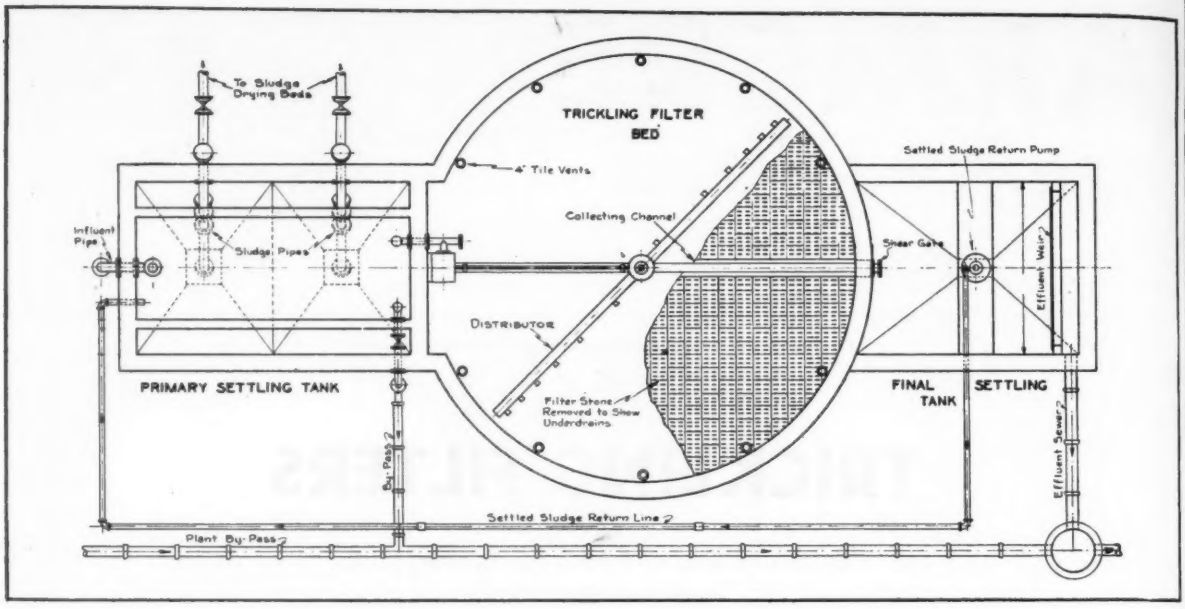


Low-rate filters at Williamsburg, Va.

New Jersey Studies

The study by Forman and Shaw of 15 plants in New Jersey, represented mostly filters dosed by spray nozzles. All but three of the primary treatment units were Imhoff tanks. Population per acre foot varied from 1250 to 5530, averaging 3150. Filter loadings, after primary treatment, varied from 129 lbs./af. of BOD to 818 lbs. Average BOD loading was 367 lbs./af. Depths are as follows; 4.75′ to 6.0′, four; 6.0′, five; 6.75′ to 8.75′, six. Effluents varied from 14 ppm. to 97 ppm. and averaged 44.6 ppm. Filter depth appeared to have no relation to the BOD content of the effluent. Insofar as individual plants were concerned, there was almost no relation between loading and quality of effluent.

No close individual relation between the loading and the BOD of the effluent is apparent, though averages do show a relation. The five plants having the best effluents (an average of 17.6 ppm. BOD) had an average loading of 276 lbs./af. of BOD, varying from 129 lbs. to 453 lbs. The five plants having the poorest effluents (average 72.8 ppm.) had an average loading of 489 lbs./af. and loadings varied from 185 lbs. to 818



A small trickling filter installation, consisting of an Imhoff tank and Water-Wheel distributor.

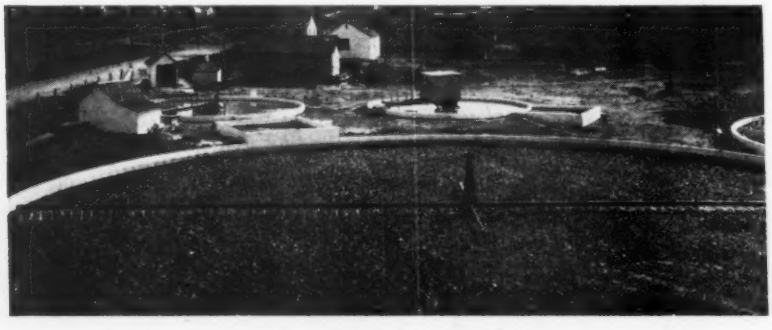
pounds. The BOD of the intermediate group of plants averaged 43.8 ppm. in the effluent and 334 lbs. loading. Arranged in order of BOD loading per af. results were: Lowest group, average loading 173 lbs./af; average effluent 37.8 ppm. Intermediate group, average loading 306 lbs.; average effluent, 44.4 ppm. Upper group, average loading, 621 lbs.; average effluent 52.0 ppm.

The NRC Army Report

The 10 army plants reported on by the NRC Subcommittee had actual average population loadings for the period covered by the report of 1700 to 12,730 per af. Army design loading was 4620 persons per af. BOD loadings ranged from 253 to 2130 lbs./af. Excluding the Great Lakes plant, which was very heavily loaded, the average loading was 443 lbs./af. Effluents ranged from 14 to 89 ppm. BOD. Depths were 6.0′ or more; and 4 of the ten filters were 7 or 8 ft. deep.

The three plants having the best effluents (average 19.3 ppm. BOD) had an average BOD loading of 350 lbs./af; the intermediate group of four plants had an average effluent of 29 and loading of 490 lbs.; and the final group, an average effluent of 69 and a loading of 1006 lbs. Arranged by loadings, the three plants with lowest average loadings, 272 lbs./af., had an average effluent of 30 ppm.; the four intermediate plants, with an average loading of 388 lbs./af., had an average effluent of 25 ppm.; the three heaviest loaded plants, average loading, 1217 lbs./af., had an average effluent of 47 ppm.

The average BOD of the primary effluents of the 15 New Jersey plants for which full data were given was 190 ppm., and the median was 181 ppm. The average BOD of the primary effluents of the ten army plants was 229 ppm. and the median was 250 ppm. BOD loading in lbs./af. averaged 367 for the New Jersey plants and 443 for the army plants. Average effluent of the New Jersey plants was 44.6 ppm., and of the army plants 38.0 ppm. The range of effluents was, for the New Jersey plants, 14 to 97 ppm., and for the army plants 14 to 89 ppm.



A typical low rate filter installation.

What Makes The Difference?

In both these studies, covering 10 army plants, and 15 New Jersey plants, there are many examples of filters operating under almost identical loadings but producing markedly different results. For instance Turner AAF, with a loading of 253 lbs./af. BOD produced a 14 ppm. effluent; Camp Swift, with 295 lbs./af, had an effluent with 27 ppm. BOD; and Fort Sheridan, with 269 lbs./af, had an effluent with 49 ppm. Likewise in the New Jersey group, the following results are typical of the wide variations among plants: Glassboro, 200 lbs./af. BOD, effluent 14 ppm.; Totowa, 200 lbs./af, 34 ppm. effluent; Haddonfield No. 2, 254 lbs./af, 86 ppm. effluent.

The causes for such variations in results have not been determined. The army plants studied were all well-operated, and the broad bases of design were sound. There remain such factors as "treatability" of the sewage, a word that cannot be defined in any precise terms. There is some evidence in the NRC report that military sewage is more rapidly oxidized than municipal sewage and the value of the reaction velocity constant was observed for four of the plants just discussed; but this should not materially affect the data presented. There may be factors in design or construction, such as the provision of more adequate ventilation and underdrainage, that affects the quality of the effluent. No data are now at hand to indicate the effect, if any, of such differences in construction, or of the size of stone used.

Regarding this paragraph, Mr. Waring says: The condition of the filter, healthy or otherwise, is a deciding fac-

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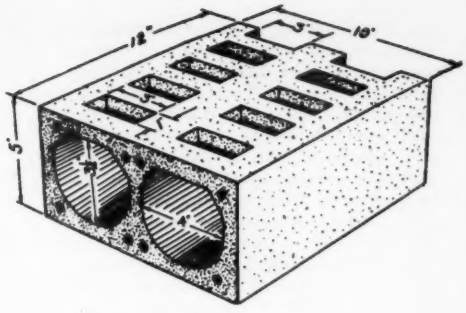

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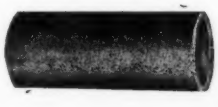

BOSCO *Extra-Quality* DRAIN TILE and FITTINGS

BOSCO PLAIN END PIPE and TRU-LINE COLLARS (Plain and Perforated Pipe)

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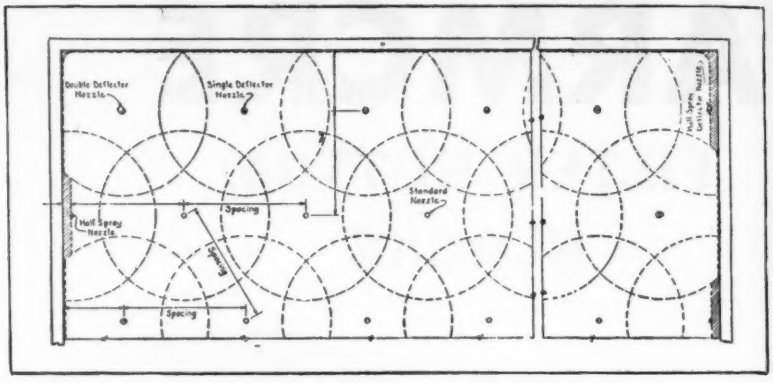
tor. Possibly some of the divergence of results between Turner AAF and Camp Swift, and Fort Sheridan is due to geographical location and weather. The test period, January to August in Illinois, would represent the period when filter operation was at its lowest efficiency. Checking operating results of filters here in Ohio, we find this is the case. During August, September and October, filter performance is extremely high, bringing the average up to the level used for design purposes. We had hoped to summarize operating results for a number of trickling filter plants in Ohio, but were unable to complete it in time for this issue. We will send it later.

Depths.—In the New Jersey investigations, the depth of the filters did not appear to be related to the quality of the effluent. However, the authors of the report state that "deeper filters, in general, show a higher percentage of reduction of free ammonia than the more shallow filters." The deeper filters in the army installations appeared to produce the better effluents, though it is difficult to evaluate all of the factors that may contribute to good or bad final effluents.

Summary of Design Procedure

Assume that (1) State Board of Health regulations permit a loading of 400 lbs. BOD/af.; (2) the flow is 1 mgd.; (3) BOD of the raw sewage is 300 ppm.; (4) a BOD removal of 35% by primary treatment is anticipated; (5) a filter depth of 7.5′ is possible without pumping; and (6) 1 hr. detention will be provided in secondary settling tanks.

The BOD loading will be 300 (1—.35) x 8.33 = 1625 lbs., and the filter area required will be 1625 ÷ 400 = 4.06 af. Since the underdrainage and the floor slope will require nearly a foot of elevation, a 6-ft. depth of filter will be assumed. The required area is 0.6768 acre or 29,477 sq. ft. This can be supplied with two filters each 137 ft. in diameter. Allowing a slope of 2″ in the semidiameter for the underdrains, 5″ for the depth of the underdrains, 3½″ for the slope of the central drainage channel, and a depth for the central channel of 6″ at the upper end, the invert of the outlet will be 7′4½″ below the surface of the filter. The elevation of the secondary settling tank or tanks will depend on the distance from the filter and the loss of head through pipe, fittings, etc.



Available sprinkler type nozzles, showing coverage of bed.

Distribution Equipment

Distribution equipment for trickling filters is of two general types—rotary

For Better Trickling Filter Operation—

ARMCRE Filter Bottom Blocks meet all requirements for an efficient underdrain system:

1—ADEQUATE AIR SUPPLY Area of ducts is 50% of cross-sectional area. 14 apertures in top total 38.5 sq. in. or over 24% of area. Large number and size of apertures allows air to pass from underdrains and circulate freely through filter media.

2—RAPID DISCHARGE Glazed surface and circular shape of ducts insures high velocity during low flow. Solids do not accumulate.

3—DUCTS CAN BE ALIGNED EXACTLY Center line scored on blocks so they can be laid to exact alignment to insure low frictional losses.

4—EASILY ACCESSIBLE Cross-section of ducts is big enough to permit quick inspection of underdrains without disturbing filter media.

5—PERMANENT CONSTRUCTION Blocks laid with reasonable care are as permanent as the filter itself.

6—ECONOMY Weighing only 28 lbs. each, ARMCRE Blocks can be installed quickly by unskilled labor. Low height of 5″ means less excavation.

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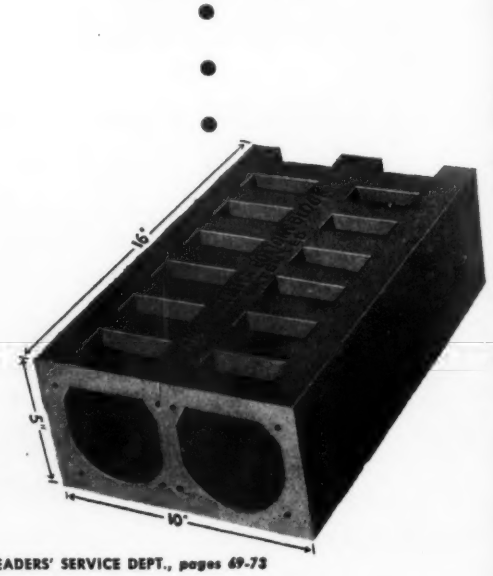
ARMCRE
FILTER BOTTOM BLOCKS



When you need special information—consult the classified* READERS' SERVICE DEPT., *pages 69-73

distributors and fixed nozzles. In this article only the equipment generally used for low-rate filters will be described; that for high rate filters will be considered later.

In selecting distributing equipment, the probable maximum and minimum flows should be estimated with considerable care. With this information, the manufacturer should be consulted for recommendations in regard to his equipment. All of the manufacturers have engineers who are qualified to select that equipment best suited for the particular installation.

Rotary Distributors

Several types of rotary distributors are shown in the accompanying illustrations. These consist, in general, of 2 or more horizontal pipe arms, having orifices properly designed to distribute the sewage. The arms and the central column to which they are attached rotate so that each portion of the filter bed receives successive applications of the sewage. Most rotary distributors are revolved by the reaction of the discharge through the orifices, all of these being on the same side of the arms. Therefore, if the discharge is too small to provide the necessary reaction, the distributor will not revolve, and a portion of the bed will be overdosed. Most distributors will operate satisfactorily with a minimum discharge that is 40% of the maximum, that is, they will handle flows up to 2½ times the minimum, but 4 ft. of head should normally be provided with this ratio.

The flow of sewage does not always fall within the operating limits of the distributor, and a dosing tank is usually provided. The high water level of the dosing tank may be 2' to 4½' above the level of the orifices in the distributor arms. However, where local conditions require that every possible inch of fall be conserved, special designs are available and the manufacturer's engineer should be consulted. Distributors having 4 arms, arranged so that 2 arms serve for low flows and 4 arms for high flows permit operation with flows up to about 5 times the minimum. The same result can be obtained by having two channels in each arm, an upper and a lower one. In all cases where high flows may occur, the hydraulics of the siphon, the feed pipe and the distributor should be calculated carefully to insure that the friction head is not so great as to cause the siphon chamber to overflow.

The head losses between high water level in the dosing tank and the top of the filter media has been analyzed by Mr. Rankin, as follows:

Hs, the entrance loss, including the siphon, may be assumed at $4v^2 \div 2g$, where v is the velocity in the filter feed pipe.

Hdt, the dosing tank loss, is the drop in level in the dosing tank required to fill the distributor arms, and equals the volume of the arms in cubic feet divided by the area of the dosing tank in sq. ft.

Hf, the friction loss in the feed pipe, is computed from pipe flow tables, using C=120 and making allowances for bends and for increase in velocity head if the feed pipe is smaller than the siphon.

Hd, the distributor loss, can best be obtained from the manufacturer; 12 ins. is the usual permissible minimum.

Ha, the distance from the center line of the distributor arm to the top of the media; usually 6 ins.

The dosing tank should usually provide about 2 minutes detention at twice the average rate of flow. This allows frequent dosing, prevents the bed from drying out and keeps the size of the dosing tank within practical limits. Since every foot of drawdown in the dosing tank represents so much head loss, and since the top layer in the dosing tank is distributed most effectively over the filter surface, it is customary to maintain a drawdown or 10" or not over 12". The low water level in the dosing tank, that is, the elevation at which the siphon cuts off, must be high enough to prevent dribbling, usually not less than 6" nor more than 12".

Where dosing tanks are not employed and the sewage is pumped or discharged

Long noted for mechanical strength and simplicity of construction . . .

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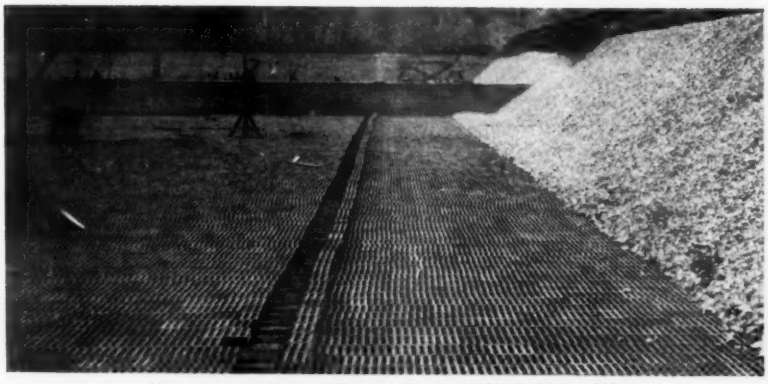
Two-Unit Trickling Filter Floor



Metro two-unit floor at Sewage Treatment Plant, Akron, Ohio

★ superior performance proved by many installations since 1926

★ area of channels is 64% of cross sectional filter area

★ area of apertures is 40% of filter floor surface

★ high grade de-aired clay, vitrified, impervious to chemicals

★ adaptable to circular, rectangular or octagonal floor design

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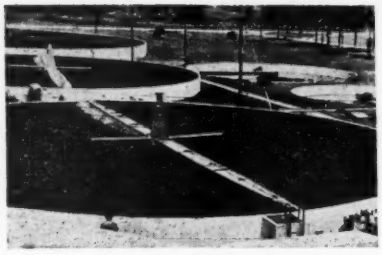
from a head box, the distributor must be designed to take the flow as it is received. Head requirements include entrance, friction and distributor losses; the latter depend on the ratio of maximum to minimum flows. Since the head on any distributor orifice varies as the square of the rate of flow, for flow ratios of 2:1, the head ratio will be 4:1.

Rotary distributors can be supplied for almost any desired diameter of bed up to about 200 feet; and there is also available an exceedingly small distributor—the Water Wheel—which is made for diameters of 5 to 25′, to serve populations of 12 to 300 persons.

Manufacturers of rotary distributors for low-rate filters include Dorr, Infilco, American Well Works, Pacific Flush Tank, Yeomans and Carter.

Nozzle Distributors

Filter beds may also be dosed by spray nozzles. The sewage flows into a dosing tank equipped with a siphon to provide intermittent discharge. The sewage is sprayed into the air and allowed to fall on the filter. Two dosing tanks are preferable, an automatic control changing the flow when one siphon tank is filled to the empty one. The filled tank is then discharged into the bed through the nozzles. In order to obtain uniform application of the sewage to the surface of the filter, the siphon tank is made smaller at the bottom so that, as the head decreases and the area of filter covered by the spray becomes smaller, the volume of sewage applied will be less.



Dorrco Distributors at Keesler Field, Biloxi, Miss.

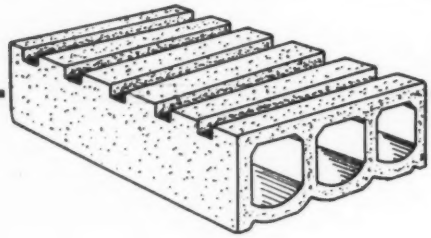
The flow-line of the dosing tank, when full, may be 5′ to 10′ above the surface of the filter. With a head of 10′, each nozzle will cover about 180 sq. ft. of filter; therefore for a filter one acre in area, about 240 nozzles will be required. About 50 gallons of dosing tank capacity is needed per nozzle or about 12,000 gals. total per acre for the condition assumed, which might be provided in two or more dosing tanks. The rate of discharge will then be such that from 2¾ to 3¼ minutes will be required to empty the dosing tank. The nozzles are usually spaced at the apices of equilateral triangles, and nozzles can be designed to cover areas that are circular, square, hexagonal, half-round or half-square.

The nozzles are fed by a grid or lines of piping laid usually 1′ to 3′ below the surface of the filter; though the pipe may be laid on the surface of the stone or on the floor of the filter.

Most or all of the 15 New Jersey plants reported on earlier in this article used spray nozzles for distribution, but there were few such plants used by the army. Fort Knox was a notable example of a large army installation using spray nozzles. A handicap to the use of spray nozzles in many plants is the head required for their operation. This may aggregate as much as 17 ft., including 10 ft. in the dosing tank, 6 ft. depth of filters, and 1 ft, elsewhere. However, total heads as low as 5′, measured from the high water line of the dosing tank to the surface of the filter, are possible with due care in design, according to Mr. Langford.

The size and shape of the dosing tanks, the economic spacing of the nozzles, and other highly technical items contribute to make design for spray nozzles complicated; and there are few engineers who will not benefit by aid from the manufacturer of these nozzles, the Pacific Flush Tank Co.

The fourth installment of this article is scheduled to appear in the May issue. It will cover design and other data on Biofilters. Other high rate fillers will be covered in later installments.



TRANSLOT

The Efficient Filter Block with the Transverse Slot

TRANSLOT blocks are made from Vitrified Clay, the EVERLASTING and ACID PROOF material. Its Salt Glazed, smooth walls permit the rapid flow of sewage.

Transverse Slots across the top of the block provide properly proportioned openings into the ducts for collecting downward flow of liquids and the upward passage of AIR.

Lengthwise grooves on under side of each block hold alignment when laying. Uniform in size, 6 blocks cover a square yard of filter floor. Self aligning and self spacing, they are easily and rapidly laid on 1 foot centers. Translot, made with standard fittings, can be used on all types and designs of Trickling Filter Beds.

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4. Cross Ventilation betwen ducts made possible by transverse slots.
5. Furnished with all shapes—Manufactured to your plans.
6. Properly proportioned apertures provide thorough ventilation and rapid run off.
7. Close dimensional tolerances and carefully inspected.
8. High in compressive strength—Low in absorption.

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PUBLIC WORKS DIGESTS

Sewerage

Water Supply

Highways and Airports

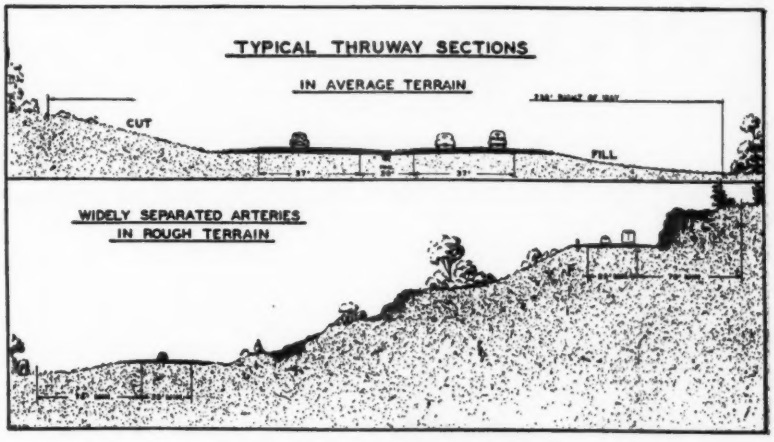
This section digests and briefs the important articles appearing in the periodicals that reached this office prior to the 15th of the previous month. Appended are Bibliographies of the principal articles, in which the articles in each periodical are numbered consecutively throughout the year, beginning with our January issue.

The letter and number at the end of each item refer to those used in the Bibliography. Numbers not found in the current Bibliography will be found in the one published the previous month.

The Highway and Airport Digest

New York's "Thruway"

New York State has begun work on a 486-mile thruway through the Hudson and Mohawk valleys from New York City to Buffalo and the State's western boundary. The right-of-way will have a minimum width of 250 ft. Grades are limited to 3%; sight distances to 1,000 ft., and curves to 2800 ft. radius. There will be two 37 ft. arteries in each direction. A central wall with a minimum width of 20 ft. will separate opposing lanes of traffic. The pavement will be 9" of concrete on 12" of gravel. Bridges will be designed for H20-S16 loading.[E14]



Typical sections of the Catskill Thruway.

Aerial Surveying on the Alaska Highway

The Alaska Highway crosses what was in 1942 perhaps the largest unmapped wilderness left on the North American continent. It was necessary to map, under war emergency, an expanse 1,500 miles long and 100 to 250 miles wide. Ground surveying was impossible and aerial surveying was the only solution. Reconnaissance flights were made along compass courses between airfields, and possible routes and impassable obstacles were located by them. Then vertical photographs were taken along several of the possible routes, and stereoscopic studies made, showing topography and soil and drainage conditions. The vertical photographs were used in the field by the location engineers to plan the advance from point to point of the general route selected. Construction followed close behind the locating party — sometimes forcing it to decide on one of several possible routes without sufficient examination of them all.

By trial and error the engineers acquired experience and eventually became adept in the use of the aerial photographs. Practical procedures were worked out, and principles of photographic interpretation were evolved for the subarctic region, though some of these principles were not established until the location work was well under way.[U4]

Constructing Red Lake Highway

Red Lake Highway is being constructed into northwestern Ontario under unusual difficulties. There is no access to any part of the road, except the beginning, by highway or rail, water transport is roundabout and slow, and much of it only by light barges; so much of the equipment was flown in (at $100 a ton) and the larger pieces brought in by water had to be disassembled. Therefore only the lightest equipment practicable was used. One of the seven contractors, working in a rolling country of clay, sand and gravel, used a 1¼ cu. yd. and a ½ cu. yd. dragline, and a ¼ cu. yd. combination dragline and shovel, 4 bulldozers, 4 tractors, an 11 cu. yd. scraper, 2 motor graders and 13 trucks. In building up the grade, draglines were used in side-casting, which enabled working during heavy rains when hauling tractors would have mired. For raising the grade, the ½ cu. yd. dragline and ten 3-ton dump trucks were used. Three weeks were lost when a forest fire necessitated removing the equipment and using the men to fight it.[O7]

Vertical Sand Drains

Sand drains or sand piles are used to provide escape for water in the soil on which embankment is to be placed, and thus accelerate subsurface consolidation. Holes 18" to 22" in diameter are drilled or bored 30 to 60 ft. deep and filled with porous material graded from coarse sand to fine gravel, so spaced that each hole drains an area of 100 to 400 sq. ft. A blanket some 2 ft. thick of the porous material is placed over the top of the sand-filled holes and extended beyond the point which will be reached by the toe of the fill,

Because of the acceleration of settlement of the fills, they can be paved earlier. The holes can be excavated by cutting or augering out the material, by jetting down a casing, by driving with a piledriver and plugged mandrel, or otherwise. In the job described, one contractor used a casing with double walls, a 16″ pipe inside a 19″ one, the two connected at each end. At the bottom, 24 jet nozzles are fastened, 16 of them pointed straight down and 8 of them at an angle toward the center of the tube, receiving water forced into the annular space under 200 lb. pressure. The loosened material rises through the inner pipe and spills over the top, assisted by compressed air. When the tube has reached the desired depth and the overflow runs clear, sand is poured into the tube, which is withdrawn as the hole is filled. Another contractor had jets at the bottom of the inner pipe, the loosened material rising through the annular space. When the tube reached the desired depth, the inner pipe was withdrawn and the sand fill poured into the outer one.[E26]

Two-Way Radio For Highways

In 1938-'39 California installed five radio stations for directing snow fighting and handling winter traffic, with six mobile units equipped to "talk back." Today it has 24 land stations and 50 radio-equipped plows and cars. Four 200-watt stations have a range of 200 miles, and the 20 50-watt stations have a 50-mile range. A full-time assistant is in immediate charge of radio work; three radio technicians maintain the equipment, and experienced snow plow men operate it. These operators have restrictive licenses. The Federal Communications Commission issues licenses limited to emergency transmissions, but have been petitioned for a broader license similar to that issued to highway police. If this is obtained, California plans to employ 2-way radio for operational direction of all general maintenance and construction. They believe that the cost of installing and operating such a system will quickly pay for itself in better highway safety, traffic control and organization efficiency.[N33]

Construction on the Dual-Dual Highway

Constructing New Jersey's Dual-Dual highway is largely a reconstruction job; but because of changes in profile, little of the old pavement was used as a base, and it was broken by rippers and power shovels and removed. The shallow earth excavation was performed with bulldozers and carrying scrapers and the subgrade compacted with 10-ton rollers. Generally a 12″ sub-base of clean dredged sand with a silt content of less than 2% was spread in two 6″ layers and consolidated to 97% maximum density by ten passes of a 14-ton tractor. Cinders used for sub-base at one point lost 40% of their loose volume by compaction.

The concrete surface was mixed 1:1.71:3.50 with 4.4 gal. of water per bag. An air-entraining agent added at the mill figured 6.7 bags per cu. yd., giving 3% to 6% entrained air content. Shoulders were made with a 14″ compacted sub-base, a 4″ waterbound macadam base of 2½″ stone, thoroughly rolled, and a 3″ modified penetration macadam, surfaced with a 1″ layer of cold-mixed asphaltic concrete.[S1]

Rubber-Asphalt Joint Fillers

Rubber-asphalt blends have been used for some years as joint fillers in concrete pavements and in general have been found superior to the more common types of hot-poured materials. The failure of some rubber-asphalt compounds to serve satisfactorily has been traced to overheating these materials and to holding them at high temperatures for long periods at the time of pouring. Such treatment causes chemical changes that alter the physical properties of the materials and consequently impair those characteristics which make the materials efficient joint fillers.

Laboratory tests indicate that rubber-asphalt compounds should be heated to closely controlled optimum temperatures predetermined for each particular blend. Batches should not be heated for extended periods, and an expeditious

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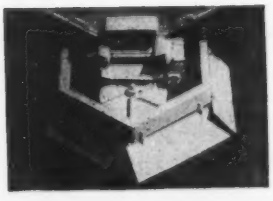

Close-up of spreader mechanism. Note special baffle plate guards . . . an exclusive BAUGHMAN feature.

Rebuilding road shoulders — an easy job with the BAUGHMAN when not used as a cinder spreader. Baffle plates and distributor are quickly and easily removed.

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"THE LONGEST MILE," *a 30-minute, full-color, 16-mm. sound film on the development and importance of roads is now available for showing to highway officials, engineers and civic groups. Ask the Barrett field man for it, or write the nearest Barrett office.*

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mechanical method of pouring should be employed.

Experiments show that the prolonged flow test required in the present specification for rubber-asphalt materials can be supplanted by the easier and quicker softening point test. The cone penetrometer test, also required at present, can be replaced by the standard needle penetration test.

Users of this type of material should provide for closely controlled temperature during heating with no possibility for local overheating. The optimum temperature for the particular filler should be accurately determined and maintained during the heating period within narrow limits. The batch being heated should not be held at pouring temperature for extended periods. Some effective mechanical means of pouring to expedite the placement of the filler material should be developed. Since these materials if properly handled are superior to the joint-filling and sealing materials in general use, adequate means should be taken to insure that these materials are not unduly injured before they are placed in the joint. [U5]

Constructing Soil-Cement

In constructing soil-cement roads in North Carolina, one contractor, instead of distributing the cement in paper bags and spreading with a rake, obtains his cement in bulk, loads it into dump trucks by a screw conveyer, and tows behind the truck a home-made spreader somewhat like a sand spreader. This spreader receives the cement on a belt 7-ft. wide driven by traction, the amount delivered by the belt being controlled by two adjustable strike-off plates, and checked by passing the spreader over a 3 x 3 ft. canvas and weighing the amount deposited thereon. When cement has been spread over a 500 ft. length, a P & H stabilizer mixes and spreads; then a patrol grader scarifies and shapes, and a harrow is backed over the section to prevent formation of cleavage planes. A sheepsfoot roller (with lugless feet so it can work in either direction) compacts it, followed by a pneumatic roller. After 6 or 8 hr. the surface is shaped with a grader, given a pass with a drag broom and pneumatic roller, and after 7 days is surfaced with asphalt. [S2]

A Dual-Line Virginia Road

A 2.6 mi. dual-lane flexible pavement expressway is being built on U. S. Route 11 west of Salem, Virginia, consisting of two 24 ft. roadways separated by a 4 ft. wide, raised, sodded median strip. The pavement is a 10" waterbound macadam base on a 4" compacted subgrade of limestone screenings, topped with 1½" of mixed-in-place asphalt surface treatment. A loose 6" layer of screenings compacts to the 4" subgrade. In all cuts where the road grade is 4% or more, the side ditches are paved with 1:2:4 cement concrete 4" thick. [S5]

New Ideas in Equipment

The author predicts that new models reaching the market within the next two or three years will supplement machines and vehicles already in service but will displace only those units that are waiting to be junked. The present basic types of earthmoving, hauling and material-handling equipment will be retained but radically improved. There is a definite trend from crawler to rubber-tire traction, but the former will always be needed for heavy slow-speed operation. Two manufacturers offer track-type tractors with 130 drawbar horsepower. Others produce 2-wheel tractors. "There is apparently no limit to the equipment that inventors can build onto a tractor, such as front-end shovels, bulldozers on pneumatic-tired tractors."

In power shovels, speed of dipper loading and swing is being increased, fingertip control perfected. Electric shovels transmit power to the hoist drum without sliding gears and mechanical clutches. Crawler tracks are being improved but there is increasing use of the rubber-tired truck crane and excavator. Conveyor shovels have much greater capacity than dipper shovels of comparable size. There is increasing use of wagon drills and factory-made detachable bits. Belt conveyors have been greatly improved by use of a steel-corded belt permitting single flights as

by the world's exclusive roller specialists. A low pressure, ample capacity hydraulic steering circuit, plus an efficient clutch shifter, insure easy and prompt response to operator's touch. Notice the simplified clutch shifter mechanism illustrated at the right. It is easy to see why Buffalo-Springfield rollers last longer with lower maintenance costs. See your Buffalo-Springfield distributor today.

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The Oldest and Largest Builder of Road Rolling Equipment in America

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long as 3 miles; also by the two-way belt conveyor.

Trucks continue to increase in size, speed, horsepower and durability, and in use of diesel power. All-wheel drive and 4-wheel tandem drive are increasing the working capacity of the motor grader. More use will be made of heavy-duty power take-offs to drive equipment. More attention is being paid to driver comfort, such as power steering. Tires are being improved, as by use of wire cord and rayon, and the rims widened.

In mixers for paving concrete, improvements include long booms, fully controllable spreading buckets, automatic power controls, faster cycles, greater capacity, gears running in oil. Complete push-button control of batching plants is reported. One of the newest things in portable crushing plants is individual electric motor drive for each screen, conveyor, etc., with power from a diesel-electric generator. In asphalt paving, the trend is toward plant-mix. The rotary mixer has been vastly improved for pulverizing, aerating and mixing soil mixtures; a new machine will spread bulk cement on soil-cement projects.[E24]

Aerial Surveys For Highway Location

Aerial surveys have been used in preliminary location of highways in the states of New York, Connecticut and Massachusetts, among others, and all find they give very accurate maps, in much less time and at much less cost than surface surveying. One survey of a 19-mile strip 500 ft. wide in Massachusetts was estimated to cost $23,000 and require 6 months' time of two field parties, but an aerial survey 6,000 ft. wide cost $12,895; a check survey showing that the elevations were correct within 1.25 ft. During the past 16 yr. the Massachusetts highway department has contracted for aerial surveys for locating 7 highways, and finds, among other advantages, that they give a complete inventory of surface features such as buildings, cemeteries, soil types &c; the photograph is easier for a jury or other laymen to read than a map, is on 3 to 6 times as large a scale as existing maps, shows "before" and "after" conditions in highway construction which give definite evidence of limits of property damages.[L3]

Reflector Beads in Pavement Marking

Michigan State Highway Dept. has adopted the proposed national standard method of traffic marking for center lines, "no passing" zones, crosswalk boundaries, "stop" lines, obstructions, railroad crossings, parking areas, "no parking" curbs, etc. The paint coats usually consist of opaque pigments and oleresinous varnishes that provide excellent durability. To provide better visibility, they began in 1939 the use of beaded reflectorized paint, which uses small glass spheres imbedded in wet paint; this providing several times the night visibility of the best paints without spheres. The department applies 12 to 14 gal. of paint per mile of 4" line, with 6 lb. of beads per gallon. The cost is about 3 times that of paint alone, but its durability is greater and, all things considered its annual cost is about the same. They have devised a bead dispenser and skip-line control device which gives a continuous 20 = 20 ft. skip line and will repaint a previous one with not more than 6" variation in a mile.[N26]

Proposed "Driving Line"

A suggestion of E. L. Worthington, West Virginia road commissioner, is the substitution of a stripe in the middle of each traffic lane instead of stripes separating lanes. The driver could more easily follow a "driving line" right under him than at one side, especially at night, and need not fear running off the pavement. Stripes would last longer. Less danger of collisions.[N27]

Soil-Cement in North Carolina

North Carolina used soil-cement on six experimental projects during 1937-'41 with soils ranging from beach sand to heavy clay, which have given good

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service at low maintenance cost, and during 1946 contracted for 130 miles of it and built 15 miles with its own maintenance force. It also used soil-cement for repairing 60,000 sq. yd. of sand clay and macadam bases and concrete in 1946; digging out the failed area 10" to 18" deep and backfilling with a mixture of sand, clay, cement and just enough water for maximum compaction, which was mixed in a concrete mixer and tamped in place in 3" layers.[R4]

Dump Trucks For Hauling Concrete

Recent experiences have demonstrated that air-entrained concrete can be processed at a central mixing plant and delivered as much as 15 miles away, free from segregation, in ordinary water-tight dump trucks. These are more maneuverable than the mix-in-transit trucks, eliminate wheeling or buggying of the concrete, and deliver concrete with less damage to the roads, and 20 to 30% more concrete per day with the same number of delivery units. Also the trucks can be used for other purposes when not hauling concrete.[E22]

Traffic Striping

New York, Virginia, Missouri and other states have developed equipment for painting traffic stripes, including devices for mechanically starting and stopping the paint spray to duplicate exactly existing variable-length dash lines. Three of these are described in this article. New York's machine makes the broken stripes automatically by means of a cam arrangement that opens and closes the paint guns at regular intervals, using three paint guns operating separately so that parellel solid and broken lines can be painted at the same time. The paint is forced out by compressed air.

In Virginia, the paint is pumped, the discharge pressure being varied according to the condition of the road surface, and the spray is begun and cut off by hand-operated valves. Missouri in 1946 used 53,350 gal. of paint in striping 3,100 miles of pavement at a cost of $27,321 exclusive of paint. The machine used has a 3 ft. tread width, a 26 ft. wheel base and 36 ft. overall length. The paint was forced by compressed air through one or more of three nozzles, and a dot-and-dash mechanism developed by the department permits regulating these to any desired pattern.[E18, 19, 20]

Stockpiling Aggregates in Ontario

The Ontario Dept. of Highways' 1946 specifications required that coarse aggregates be handled, stored and batched in two sizes—¼" to ¾" and ¾" to 1½". In previous years there was no separation and a great deal of segregation occurred in handling and stockpiling, resulting in nonuniformity of concrete. Under the 1936 specifications a denser and stronger concrete has been produced with a lower cement content.[O19]

Rubberized Joints At the Packard Track

In constructing its high-speed concrete test track, the Packard Motor Co. used a rubberized asphalt joint-sealing compound to obtain a positive seal for expansion joints. To obtain perfect adhesion, the joints were ground out with a thin-disc emery wheel, and blown out with compressed air. The compound softens at 160° and is injured by temperature above 500°, so special care was taken in heating it, using a new type of kettle, the compound being placed in an inner vat, which is surrounded by a hot oil bath, which is heated by gas burners under accurate temperature control; the hot oil not only surrounding the vat but also filling tubes that run through it.[N35]

Widening and Resurfacing a Pavement

Vermont last year widened 7½ mi. of old concrete pavement from 18 ft. to 20 ft., added a 4-ft. shoulder on each side and laid a hot plant-mix bituminous concrete surface 20 ft. wide. In digging a trench 1 ft. deep by 4 ft. wide on each side of the pavement for the shoulder,

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MUD-JACK METHOD

a ⅜ yd. shovel or an angle dozer was used at first, but later a grader with a trenching attachment which excavated a 3 ft. width and left the dirt in a windrow on the pavement, where it was picked up by a bucket loader. Gravel was dumped into this trench and spread by a power grader and compacted by rolling with truck wheels followed by a 7-ton roller.

In this shoulder was dug a trench 18″ wide by 3″ deep for a foundation for the 12″ pavement widening. Excavating was done by means of a power grader which had a drop blade bolted on the outside edge of the regular blade and extending 3″ below it, and a wing beyond this threw the excavated material out of the way. This trench was filled with gravel to which RC-2 had been added by a pug mill, 14 gal. to the cu. yd.; a spreader box being used for this.

In preparing the concrete for surfacing, all old bituminous patches were scraped off, and expansion joints cleaned to a depth of 1½″ and filled with lean sand and RC-2 to ½″ from the top. The surface was swept and primed with MCO fog coat before the bituminous concrete was placed.[P9]

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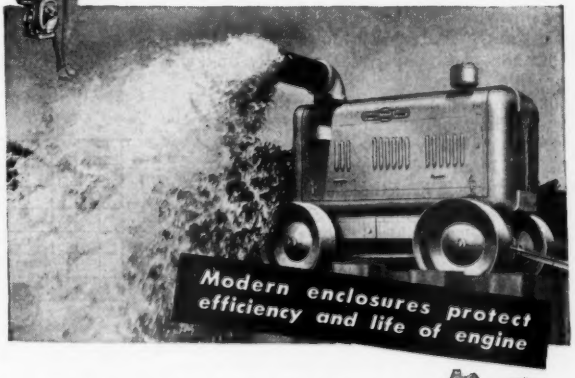

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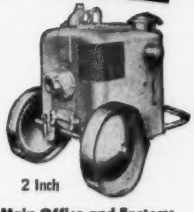

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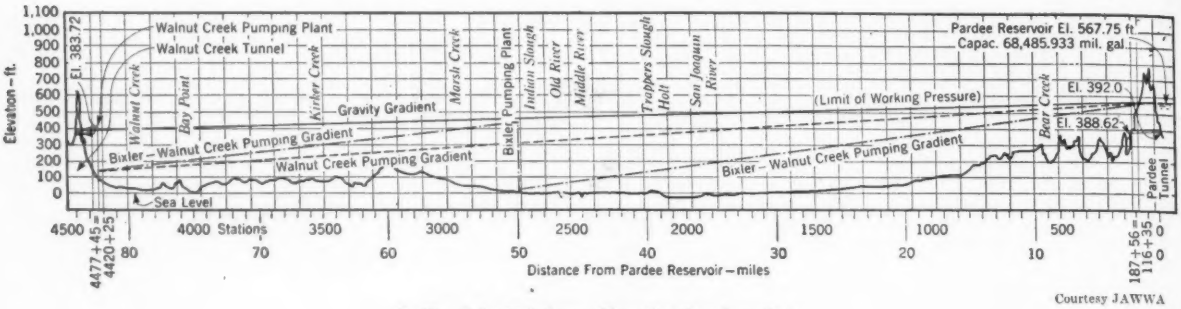


Courtesy JAWWA

Profile of the Mokelumne River-East Bay Aqueduct.

Booster Pumping On a Large Aqueduct

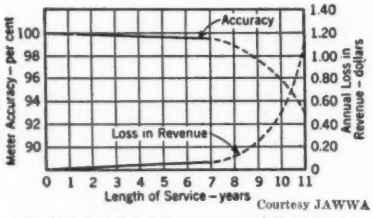
The East Bay Municipal Utility Dist., California, has increased the capacity of a closed aqueduct 61" to 65" diameter and more than 80 mi. long by installing a booster pumping plant containing two pumps, each rated at 47.5 mgd and 415 ft. total head at 900 rpm. The pumps are vertical, single-stage units, with double suction and double volutes, placed below ground to gain as much head as possible on the suction. Results have been satisfactory, and efficiency at acceptance test was 88.64% (guaranteed efficiency 87.0%). Completely automatic shutdown protection was provided, the usual sources of trouble being wired to relay circuits which shut the plant down automatically and provide a visual indication of the source of trouble. Sleeve-type throttling valves in the pump discharge are arranged to close before power to the motors is cut off on normal or relayed shut down. When the plant is placed on the line, these valves open slowly after the motors are up to speed. For surge control, an ordinary swing check valve was installed as a dividing gate in the line to separate the pump suction and discharge, and the results have been most gratifying, the transition from pumping to gravity velocities being achieved with the accompaniment of inconsequential pressure oscillations.[A33]

Efficiency of Centrifugal Pumps

It is fairly safe to state that great improvement in maximum efficiency of centrifugal pumps cannot be expected. Efficiencies of around 90 per cent are now being obtained on pumps of moderate size, and when considering the amount and nature of losses in a centrifugal pump, such as leakage and bearing, packing and impeller friction, and the loss in conversion into pressure of the large kinetic energy of the water leaving the impeller, it is easy to realize that not much improvement can be looked for. This statement does not apply, however, to the smaller sizes of pumps, where improvements are still possible, mainly due to improved surface finish.[G17]

Economic Meter Maintenance

The California Water Service Co. has developed a program for the routine inspection and maintenance of meters. The first step was to collect data as a basis for analyzing the cost of reconditioning and determining the average change in registration with years in service; and from these, determine the proper periodic interval for inspection, test and repair. Then methods were developed for utilizing these results in practice and a service manual prepared.



Courtesy JAWWA

Decline in Meter Accuracy and Revenues.

The proper time for reconditioning was taken to be that when the annual cost of reconditioning becomes less than the annual loss in revenue. The former was taken from the records. For determining the latter, 30 test meters were connected in series with service meters of representative customers, selecting meters which had been in service 4, 7 and 11 years. The average results are shown in the illustration. The accuracy of the meters was found to be nearly 100% up to 7 years, after which there were enough meters with considerable under-registration to pull down the over-all average quite rapidly. Using these figures, it was estimated that annual loss of revenue approximately equaled cost of reconditioning after 8 years of service. Individual meters may differ considerably from the averages, but the period for reconditioning lies somewhere between 7 and 11 years.[A39]

Treatment Plant Operating Costs

Among the factors having a considerable effect upon purification costs are the quality of the source, location of the intake, plant capacity, quality of the plant design, and skill and attentiveness of the plant operators. Water qualities include turbidities, alkalinities and pH values, and industrial waste pollution. In general, adequate capacity of plant lowers costs. A poor design will increase the costs of chemicals, maintenance and repairs, and power. Improper coagulation is wasteful of chemicals and may increase maintenance costs if a corrosive or encrusting water is produced. Improper backwashing can affect the net yield from the raw water. Data collected showed that the unit cost per million gallons for operating personnel is in nearly inverse proportion to the quantity of water treated.[A37]

Preventive Maintenance In a Purification Plant

Equipment of standard manufacture should be used. Although a skilled mechanic can make parts "just as good," the total cost of making major replacement parts is generally greater than if purchased from the manufacturer of the original machine. There never should be laxity in replacement or repair of machinery if this will restore its efficiency. In a small plant, repairs and preventive maintenance must

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generally be accomplished by a mechanic or other outside help employed for the purpose. In a large plant, a trained maintenance force should be kept available, equipped for making repairs on all but the very largest type of machinery. All machinery should be inspected, cleaned and tested frequently.[P9]

Pipe Line Rights-of-Way

Right-of-way may be obtained in fee or in easement. The former may be in absolute fee or conditional fee. In the former the land is owned unconditionally. A conditional fee may restrict the purchaser in his use of the land; may leave some rights for its use with the original owner or, more usually, both.

Easements in their simplest form convey merely the right to lay and maintain one or more pipe lines across a piece of property in a certain general location, affording the pipe line owner little protection against uses of the land which adversely affect its suitability for right-of-way purposes. By present practice they usually provide for access for city forces over adjacent land, specify a minimum depth of pipe, prohibit the grantor from using the land in any way that will interfere with its use as a pipe line right-of-way, permit construction or roads and utilities across or along it at acceptable locations and grades, prohibit the city from fencing it or the grantor from constructing structures or deep fills over it.

The most desirable type of right-of-way is one in absolute fee. Frequently, however, the absolute fee cannot be justified, whether because severance damage makes its cost excessive; because it is not obtainable except in short, disconnected sections; or because there is difficulty in retaining the full fee title until the time when its potential advantages will be fully realized.

Absolute fee title to the portions involved should generally be acquired whenever: contemplated construction aboveground will prevent use of the land and passage across it by the original owner; it is deemed imperative to provide for possible future construction aboveground in an area where later acquisition of the necessary rights might be impracticable; or the right of way will render a lot or other small holding valueless for building purposes.

If it is not practicable to acquire a right-of-way in absolute fee, the more positive protection afforded by a conditional fee title, compared to an easement, will more than outweigh the small additional cost involved in payment of taxes.[A82]

Public Relations

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The pH Meter in Control of Softening

Control of lime application in softening, to maintain a desired pH, ordinarily involves analyzing samples at intervals which ordinarily can not be less than 30 min. At St. Paul, Minn., this required the services of 3 analysts and a relief for 24 hr. operation, and has been replaced by use of a pH indicating recorder. The advantages of the recorder include accurate control of the application of chemicals, an increase in the capacity of the recarbonation equipment, and a decrease in the amount of carbon dioxide used in the recarbonation process produce important economies. Furthermore, close control of the feeding of chemicals improves the quality of

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sludge, diminishes filter deposits, and enhances the quality of the finished water. From the viewpoint of the operators; this scheme simplifies the adjustment of chemical-feed machines, minimizes the tedious work of chemical analysis, and by providing a continuous accurate measurement of pH definitely aids plant operation.[E10]

Developments In Pumping Practices

During the past 25 years, centrifugal pumps have displaced steam pumps, their efficiencies have constantly improved, ball bearings have come into use, turbine blading is better standardized, motor starting characteristics and equipment have been improved. Much larger motors are available. Turbine speed control devices to maintain constant pressure have been developed. Discharge line control to avoid back flow or water hammer has been improved. Recent developments include:

1. Magnetic drives for variable pump speed from constant-speed motors.
2. Hydraulic couplings for variable pump speed from constant-speed motors.
3. Automatic control of motor-driven pumps covering combinations of water elevation or pressure, unit selection, timed operation and various other factors.
4. Remote centralized control of various scattered motor-driven units in a system supplemented by telemetered indications of pressure, water level and other factors.
5. Automatic pump-priming device combinations.
6. Application of motor-driven vertical - shaft bottom - suction centrifugal pumps or various types where rather high discharge head and variable suction conditions exist.

Magnetic drives and hydraulic couplings are adaptations from the automobile field that have been applied in sewage pumps. The principal objection seems to be rather high cost.

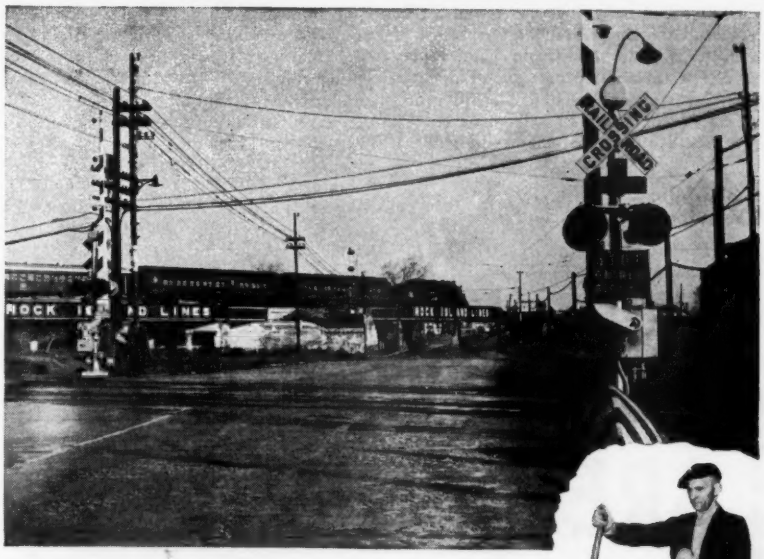
Gas turbines, jet propulsion, wireless power transmission and atomic power may come into use for driving pumps in the future.[A34]

Well Depth Determines Iron Content

La Crosse, Wis., has, since 1913, obtained its supply from 24 wells 108 to 135 ft. deep. The screens became incrusted with iron and manganese, which was removed with inhibited, stabilized muriatic acid combined with dowmetal, pumped in under a pressure of 90 psi to force it into the adjacent sand. This increased the yield of each group of 4 wells from 1¼ mgd to 2 mgd, on an average.

A study of the geological formation to a depth of 162 ft. showed that the iron and manganese water was coming from a stratum at 139-157 ft. depth, while that above 139 ft. contained no manganese and only 0.2 ppm of iron. To exclude the undesirable water, a

PROBLEM: LAYING PIPE UNDER THIS BUSY INTERSECTION WITHOUT STOPPING TRAFFIC, DAMAGING STREET . . !.



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46″ hole was sunk to 103 ft., a 36″ casing set in it, and the annular space was filled with neat cement grout. Then a 36″ hole was drilled to 139 ft., and under-reamed to 66″ diameter and a 6″ cement platform poured at the 139 ft. level to impede flow from below this level. On this platform was set 30 ft. of 24″ screen. This yielded 3600 gpm of water containing no iron or manganese and 300 ppm total hardness.[F11]

A 233-Mile Steel Pipe Line

In 1940-1944 a line of 30″ to 21″ steel pipe was laid in Australia with several interesting features. The pipe was laid above and without any contact with the ground, thus avoiding ground corrosion and giving easy access for inspection or repairs. The pipe is supported on concrete piers or chairs at 15 ft. intervals. It was lined with ½″ of cement mortar. The outside was descaled and given a priming coat of red lead, followed at first by two coats of zinc, but the last 175 mi. by "Galvanite"—metallic zinc with a suitable vehicle and catalysts, expected to have long life. Water is lifted 1558 ft. in the first 57 miles, to five 2 mgd reservoirs, and from there flows by gravity. The scheme is to deliver 1200 mg annually to Whyalla, at the further end, and 900 mg along the route.[F14]

Ammonia Liquor At Kansas City, Mo.

Due to the coal strike, Kansas City found it impossible to obtain ammonium sulfate, which they had been using to prevent chlorinous tastes. Other sources of ammonia obtainable were anhydrous ammonia and ammonia liquor. The latter was decided on and the tank and other necessary equipment installed in three weeks. The change is considered to have been advantageous on the basis of cost, simplicity, and the fact that no sulfate ions are added in converting carbonate hardness to non-carbonate. Cost of unloading ammonia liquor with air is less than unloading ammonium sulfate by hand. The cost of ammonia liquor is about $70 per ton of available ammonia, as compared to $150 as ammonium sulfate. The liquor can be fed through any type of liquid feeder and stored at any temperature. Cost of the new equipment will be paid for by one year's savings.[G15]

Costs and Rate Charges

Water rates cannot be changed frequently but should be reviewed at intervals of 10 yr. or less with a view to readjustment in order to assure the income needed. The rates should be reduced if the costs warrant. Increases may be required because of reduced water sales during a prolonged depression as well as because of increased costs. Revenue from water sales should cover all elements of cost and with insistence upon short-period revenues allocated to new capital, and upon long-period reserves for protection against inflation years.[A29]

Building San Diego's Aqueduct

A 71-mile aqueduct from San Diego, Calif., to the Colorado River aqueduct is being built by the Navy. Unusual features include siphons under heads as high as 930 ft. and pipe laying procedures. The line has a capacity of 85 cfs, the tunnels having twice this to allow for increasing the capacity in the future. Except for the deepest siphons, the pipe is reinforced concrete, sizes 48″ to 9€″.

Where the pipe was laid in earth, the trench bottom was cut to the exact shape of the pipe except for bells cut out at the joints. When the line went through rock, the trench was overexcavated a minimum of 12 in. and select backfill was compacted to 98 percent density on the bottom to fit the shape of the pipe.

After the pipe was placed, backfill around it up to just below the springline of the pipe was compacted to 98 percent of maximum laboratory density. Such compaction was very difficult in the narrow trench space in which the work had to be done. On relatively level stretches, pneumatic hand tampers on

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slightly moistened soil proved to be the most satisfactory compaction method. On steeper slopes various combinations of puddling, flooding, and jetting and poling were tried and, although the desired results were achieved, no outstandingly satisfactory method was developed.[E9]

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37. Treatment Plant Operating Costs. By Kenneth V. Hill. Pp. 151-156.
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39. Program for Routine Testing and Maintenance of Meters. By G. L. Williams. Pp. 168-172.
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14. Whyalla, Australia, Secures Water Through 233-Mile Pipe Line. By H. Bowden Fletcher. Pp. 180-182.
15. Low Demand Rate Shown by FPHA Apartment Units. By A. P. Kuranz. P. 185.
16. Deep Well Electric Pump Has Auxiliary Gasoline Motor. By Oliver A. McMulten, Sr. P. 185.

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17. Filter Sand Incrustants at St. Paul Plant. By Ross A. Thuma. Pp. 232-235.
18. Lining Small Mains in the Yard. Pp. 244, 258.
19. A Simplified System of Water Works Accounts. By Reeves Newsom. Pp. 249-250.

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13. A Water Service That Delivered Road Tar. By Fred J. Reny. P. 64.
14. Power and Water Rates as Affected by Public Demand. By Robert B. Simms. Pp. 65-67.
15. Ammonia Liquor Replaces Ammonium Sulfate. By H. W. Poston. P. 68.
16. Hydraulics for the Practical Waterworks Man. By Robert W. Angus. Pp. 69-72.
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18. Tapping a 42-Inch Concrete Main Under Pressure. By M. J. Shelton. Pp. 78-79.

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8. Pump Equipment. By Frank E. Harley. Pp. 19-20, 37.
9. Preventive Maintenance in a Water Purification Plant. By Edward S. Hopkins and A. A. Bailey. Pp. 25, 37

Swedish Road Practices

Guest speaker at the Marion, O., Lions club luncheon meeting recently was Tage Olby of the Swedish Trading Company in Stockholm and distributor for Huber Mfg. Co. in Sweden.

Stating that in general Swedish roads are very narrow, with many sharp curves, Olby explained that Sweden has only 56,000 miles of roads in the entire country, and that they are numbered according to their classification so that it is possible to know the type of road by knowing the number.

Maintenance is the great problem, due to the very extreme weather conditions. Many roads have to be blocked off entirely during the severe winter months and when the spring thaws arrive the roads are often in bad shape.

Contractors in Sweden are few (there being only about 10 or 12 large ones) and they bid on all government road construction much as is done in the United States.

When a contractor gets a job he has to guarantee his work for two years, and during that time the government keeps back about 20 per cent of the quoted sum—a precautionary measure that assures the government a good job. The laborers are paid on an hourly or piece work basis.

During the war substitutes for asphalt in building paved roads were poor and much of the roadwork done during that time will have to be done over. Sweden has a large road building program now in progress.

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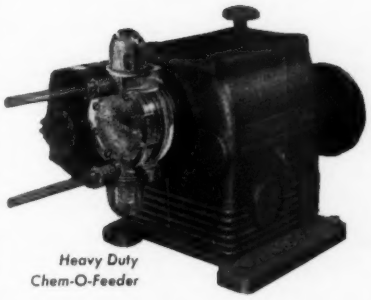

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The Sewerage Digest

Digestion Experiences

At San Diego, Calif., digesters are heated entirely by the use of live steam injected into the raw sludge as it enters the digesters. A recent improvement is applying the steam in a "constant-level" box equipped with an overflow weir. Sludge pumped to this box is heated by steam at 3 to 4 lb. pressure applied through four 4" vertical perforated pipes and the heated sludge flows over the weir to the digesters.

At Green Bay, Wis., two sludge gas engines, installed in 1937, in eight years produced 5,415,162 kwh, of which 91% was used by the District, giving a net profit of $55,870 on the investment of $41,876 by the District, or of $73,832 if including the PWA grant.[H14]

GAS ENGINE DATA

Fiscal Year	3 Cylinder - 90 HP - 80 K V A							4 Cylinder - 120 HP - 120 K V A						
	Hours Operated	Total Hours Operated to date	% Operated	% Load	% of Total Power Generated	Pt. 3 Gas per Kw.	kw-hr per Gal. Oil	Hours Operated	Total Hours Operated to date	% Operated	% Load	% of Total Power Generated	Pt. 3 Gas per Kw.	kw-hr per Gal. Oil
1937-'38	5,305	5,305	73	102	71	26	2,285	1,714	1,714	24	97	29	28	1,533
1938-'39	5,833	11,138	70	103	63	28	2,241	2,665	4,379	52	96	37	29	2,253
1939-'40	4,789	15,927	52	103	43	30	1,723	5,128	9,507	56	94	57	28	2,235
1940-'41	3,733	19,660	42	100	29	28	1,708	6,759	16,266	77	100	71	28	2,376
1941-'42	2,869	22,529	33	97	22	30	1,285	7,529	23,795	86	101	78	29	3,631
1942-'43	3,477	26,006	40	97	30	31	2,157	6,067	29,862	69	101	70	28	2,346
1943-'44	2,996	29,002	34	98	26	31	1,327	6,272	36,134	72	101	74	28	1,594
1944-'45	3,456	32,458	40	96	25	31	3,087	7,256	43,390	83	.02	75	30	2,756

Courtesy Sewage Works Engrg.

Gas Engine Operating Record at Green Bay.

Joint Treatment of Sewage of 127 Communities

The Allegheny County Sanitary Authority is progressing rapidly toward complete abatement of stream pollution by the 127 cities, boroughs and townships in the county. Already 86 have agreed to participate in the Authority's program, and 12 are committed to it by initial legislative action. Two municipalities outside the county have asked permission to join. Of 90 industries ordered to join, 27 have consented. This represents 90% of the total population of the area. Measurement shows that 200 mgd of sewage is discharged into the streams. The industrial wastes from more than 2,000 plants are being checked. It will be possible to treat all of this sewage in one plant located on the Ohio river below Pittsburgh. This would require constructing 200 miles of collecting sewers and interceptors. It possibly may be found more economical, however, to construct several plants.[L4]

Treating Tannery Wastes

Tannery wastes of the Keystone Tanning and Glue Co. are treated by Mechanical flocculation, sedimentation, flow equalization and sludge dewatering. Spent tan liquors are evaporated for recovery of salable byproducts. By this treatment, suspended solids are reduced from 2,500 ppm to 250 ppm, and BOD from 600 to 350 ppm. The sludge is dewatered by centrifugals to 85% moisture and used as fill. The liquid is flocculated with paddle mixers for 1½ hr., passes through a settling tank with a theoretical detention period of 6.5 hr., then to an equalization basin having a capacity of more than the total waste reaching the plant in an 8 hr. day, from which it is withdrawn by a float-controlled valve at a rate uniform throughout the 24 hr.[P9]

Chlorinated Copperas For Trade Wastes

The sewage of Halifax, England, contains large amounts of trade effluents of a greasy and soapy character, and sulphuric acid has for years been used as a precipitant, at times supplemented with aluminoferric. Recently studies have been made of the use of chlorinated copperas, and the following conclusions reached:

(1) Chlorinated copperas is a convenient form of ferric salt for sewage precipitation, which can be prepared on site from readily-available materials. Results obtained with it differed only slightly from those with ferric chloride and ferric sulphate.

(2) With Halifax sewage, chlorinated copperas precipitates more impurities than does sulphuric acid, but would be much more costly in use than the latter.

(3) A small dose of chlorinated copperas in conjunction with pH adjustment by sulphuric acid also brings about good clarification, and would be a more economical method than the use of chlorinated copperas alone.

(4) Addition of lime also reduces the requirement of chlorinated copperas, but the quantity of lime needed to achieve this result was somewhat excessive.

(5) Chlorinated copperas, either alone or in conjunction with pH adjustment, removes not only colloidal and non-settleable matters, but also some impurities from true solution.

(6) The iron added as chlorinated copperas is substantially all precipitated unless an excess of reagent is used.

(7) The iron so precipitated increases both bulk and weight of the sludge produced; this may be a very material factor when relatively large quantities of ferric salt are needed to effect coagulation.[I8]

Heat Treatment Of Sewage Sludge

The Porteous heat treatment of sewage sludge was described in the *Digest* several months ago. This article describes at length the process as carried on at Luton for treating a mixture of primary and secondary sludge, with data. The process is one for conditioning sludge, whereby it is concentrated more readily and completely. The sludge must be freed of rags and other large solids, preferably by passing it through a ⅜ in. screen. It is drawn into closed vessels and heated to 350°-370° F. by injecting steam superheated to 500°. By means of heat exchange, the sludge is raised to 300°-320° before applying the steam, whereby the steam raises it only 50°, requiring 0.6 to 0.85 lb. per gal. of sludge. After heat treatment for 30 min. the sludge settles quickly, having a 12% solids content, when it is pressed under 100 lb. per sq. in. pressure into cakes with 50% to 60% solids content. It is further dried in the open air for 3 weeks or longer to a 10% to 30% moisture content and is then burned to furnish the steam necessary

All drainage on this job is handled by Clay Pipe, ranging in size up to 36-inch diameter. Because Extra Strength Clay Pipe is used in many places, especially culverts, no encasement is required. Mr. G. F. Smith, Division 11, Ohio State Highway Department, is the engineer in charge. The project was designed by Mr. Levi Kimball, under supervision of Mr. Perry Ford, Ohio State Highway Director.

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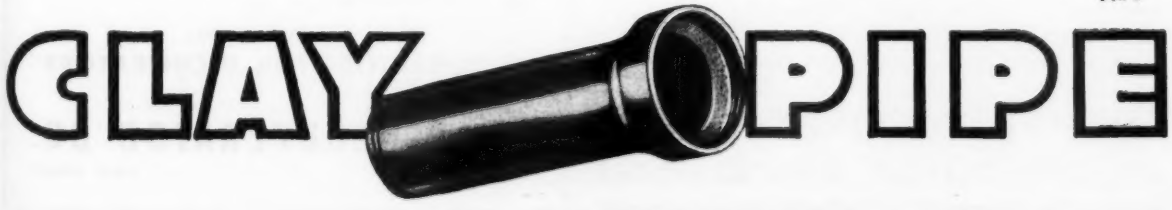

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for the process. If the sludge were digested first, the digester gas might be used for operating the pumps required by the process.

The liquor decanted from the heat-treated sludge is greenish-yellow and sour smelling; contains 7,500 ppm of total solids, 1,500 ppm B.O.D. Addition of it to the sewage had no material effect upon the quality of the plant effluent. It is claimed that the cost of this process compares favorably with that of others if the population served exceeds 50,000, but no figures are given to substantiate this.[D10]

Charges for Industrial Wastes

Two methods of charges by municipalities for treating industrial wastes are: 1—Place on the industry the responsibility of pretreatment so that the wastes entering the sewer are within prescribed standards of strength, and charging the industry on a volume basis at the regular rates. 2—Receiving the raw wastes and adjusting the rate to compensate for strength. The article presents a method and formulas for adjusting rates based on suspended solids and B.O.D. as compared to those of domestic sewage, assuming the suspended solids of the latter to be 150 ppm and the B.O.D. 200 ppm.[G8]

British Developments In Sewage Treatment

In England, fine screening is practically obsolete. In bar screens, spacings of 1½" to 2" are common, as is mechanical cleaning. The policy of screening sludge rather than sewage has some support. Constant velocity in grit channels is attempted by constructing channels of trapezoidal cross section, flow control by standing wave flame, and multiple channels.

Sedimentation tank design differs from American practice chiefly in capacity, giving 10 to 15 hr. detention period at dry weather flow without mechanical desludging, or 6 to 8 hr. if there is such desludging. This is partly due to the greater strength of British sewage, partly to the fact that their plants provide full treatment for 3 times the d. w. f., and partly to a desire to secure maximum removal of solids in the primary treatment to relieve the burden on the secondary treatment. Circular tanks of greater diameter than 60 ft. are not favored, as the peripheral sludge is removed more quickly in the smaller tanks and it is claimed that they are more efficient. At least 3 tanks are desirable, to permit of repairs to the machinery.

For activated sludge, the diffused air system is most favored, but there are many installations of mechanical aeration by the Simplex system, the Haworth or Sheffield system, the Spiro-Flow, and the Kessener brush. In the Haworth, large paddle wheels turn on long horizontal shafts in units divided into continuous channels about 6 ft. wide, the liquid usually going around the course about four times and thus absorbing sudden heavy loads by dilution. The Spiro-Flow is essentially the same except that inclined paddles are used.

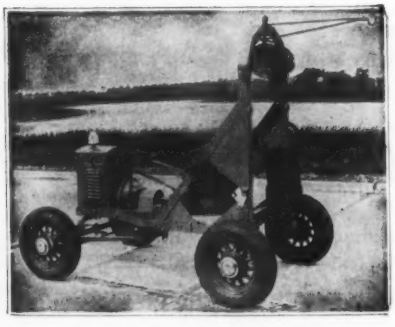
Modifications of trickling filter technique include alternating double filtration, recirculation, enclosed aerated filters, and cyclo-nitrifying filters. In double filtration, present practice favors a daily alternation; experimental plants indicate a capacity three times that of ordinary filters, with much less nitrification; but in practice, much less capacity is likely; in fact, it may be found impracticable to obtain much more than half as much.

Experiments in recirculation are limited to a 50:50 ratio. British plants aim at 40 to 50 ppm. of nitrogen as nitrate in the effluent; recirculation of larger quantities than this to the primary tanks might lead to lifting of the sludge by the gaseous nitrogen produced.

In the enclosed aerated filter, positive ventilation is obtained by driving a gentle current of air downward through the filter. Experiments for 4½ yrs. showed that such filters can treat tank effluent at 3 times the rate of ordinary open filters. Most of the work in a filter 12 ft. deep appears to be done in the top 9 ft.

The cyclo-nitrifying filter was evolved at Sheffield's activated sludge plant, the effluent of which was filtered at a high rate, producing a highly nitrified effluent which, when returned to the activated sludge plant, greatly improved both effluent and sludge.

KEEP THOSE SEWERS OPEN!



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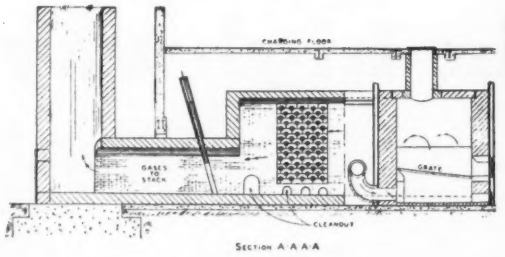

SECTION A-A-A-A

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Combination of activated sludge and trickling filters in the same plant, operated in series, is thought to have advantages. Filters tend to give trouble in winter and activated sludge plants in summer, and seasonal adjustment of the load between them can provide increase in overall efficiency.

Chlorination of effluents is not favored by Mr. Hurley. He suspects the possibility of undesirable effects down stream; and has no use for a sterile stream, preferring one replete with animal and vegetable life.[C15]

Experiences With Activated Sludge

Chicago has definitely established that clogging of porous diffusers at this plant is caused by both underplate clogging by dirt in the air, and by top surface clogging due to growths on or in the plates. It is proposed to study several variations of air diffusers, including an improved design of slotted pipe. Such pipe will undoubtedly require more air per gallon than porous diffusers, but possibly for a period of years it might be economical overall to provide more air at a lower pressure than to do the necessary extra air cleaning and plate cleaning and furnish less air per gal. at a higher pressure.

In Cleveland, aluminum diffuser plate holders were coated with bitumastic, but after 18 months this loosened and tore away from the bottom surfaces and corrosion of the aluminum continued.

At Marshall, Wis., due to the heavy clay and silt content of the sewage in 1946, the volatile solids content of the activated sludge was only 40 to 60% instead of the normal 75 to 85%. The sludge settled rapidly, the sludge index was low, and the air requirements much below normal; so apparently the clay and silt were beneficial.[H14]

Algae Stimulated By Plant Effluent

In Back River, which receives the effluent from Baltimore's treatment plant, algal growths are so abundant in warm weather as to make the water look green, and for 20 to 30 ft. from shore the growth is so dense that small fish find it difficult to swim through it. This growth is promoted by the nitrogen compounds in the sewage effluent, and by the carbon dioxide produced by the aerobic decomposition of organic matter.[H18]

Pre-Aeration For Trickling Filters

Pre-aeration for 10 to 20 min. assists grease removal. Pre-aeration for 30 to 40 min. provides flocculation and increases sedimentation and B.O.D. removal to 60% to 75%, freshens stale sewage and sends to the filter a sewage containing dissolved oxygen and aerobic biologic forms, thus increasing its capacity by 30%. Also if digester supernatant is discharged to the pre-

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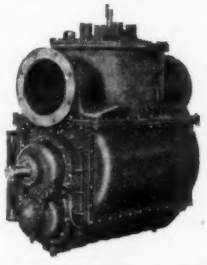

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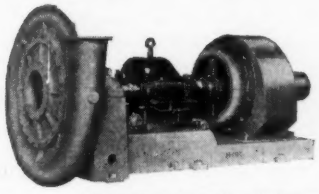

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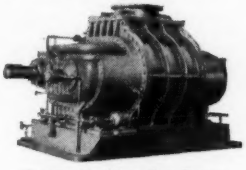

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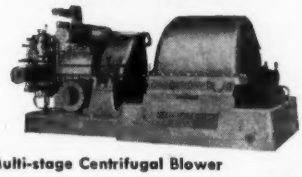
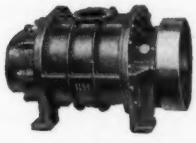


Multi-stage Centrifugal Blower



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aeration tank its adverse effect on secondary treatment is reduced or eliminated.

It is contended that present standard filter design loadings are unnecessarily conservative in the light of advancing knowledge of factors affecting their performance. We believe that standard filter loadings of 500-800 lb. B.O.D./acre ft. (87 to 55 cu. ft./lb.) are entirely reasonable if a fresh sewage is applied to filters *not less than 4 ft. deep,* and if sufficient attention is given to preliminary treatment, distribution, recirculation, media size and ventilation through an adequate underdrain system.[G7]

Trickling Filter Experiences

At Worcester, Mass., the filters did not unload during 1943, '44 or '45. The iron content of the filter influent makes it dangerous to use chlorine to prevent clogging because of the danger of precipitating the iron. There was excessive pooling, which was not relieved by use of bars or by resting, and it was found that 50% of the filter capacity was filled with clogging material.[H14]

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Z *Technique Sanitaire et Municipal*
November-December

3. L'Assainissement des Villes. Report by M. Gaultier. Pp. 74-77.

Stream Pollution Abatement in Illinois

The Illinois Sanitary Water Board recently announced action by the Commercial Solvents Corporation to abate Illinois River pollution resulting from the discharge of distillation residues from the Corporation's plant at Peoria, Illinois. This action was the result of a series of studies, conferences and negotiations between the Corporation, the technical personnel of the Greater Peoria Sanitary District, and the State Sanitary Water Board. The wastes result from the manufacture of industrial solvents utilizing corn and molasses as the raw materials in the process.

In commenting on the installation, C. W. Klassen, Technical Secretary of the Board, stated that the installation when completed will recover a valuable livestock feed supplement from the wastes now discharged to the river. It is calculated that the proposed recovery plant will remove pollutional material from the river equivalent to the domestic sewage from a city of approximately 350,000 persons. The installation will include additional boiler capacity, evaporator and drying equipment. This installation is the final increment in the stream pollution-abatement program of the Commercial Solvents Corporation and will effect complete recovery of all solids contained in the distillation residues when the plant is operating at capacity production. It is estimated that approximately twelve months will be required to complete the installation of the proposed equipment.

In 1938 the Commercial Solvents Corporation installed a recovery plant for a portion of its process wastes which at that time reduced the pollutional

A Better Way of Heating Sludge Digestion Tanks . . .

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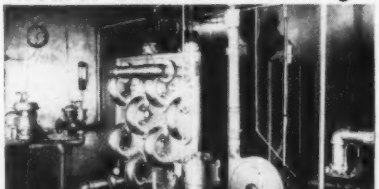
. . . does away with constantly decreasing heat transfer, greatly reduces the labor of cleaning coils, and minimizes the operating interruptions encountered in the conventional method of heating digestion tanks. Ask for Bulletin 135.



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load by an amount equivalent to the domestic sewage from 138,000 persons.

The installation of this recovery equipment is the result of considerable study and research on the part of the Commercial Solvents Corporation extending over a period of several years.

In commenting upon the industrial pollution abatement program of the Illinois Sanitary Water Board, Mr. Klassen stated, "while the abatement of stream pollution is our primary objective, promoting the recovery of by-products from waste material has been a definite part of the Board's program, and action by this large corporation is illustrative of the excellent cooperation which has been received from Illinois industry."

Aeration in Sludge Conditioning

At New Britain, Conn., vacuum filtration and incineration continue 24 hr. a day for 6 days a week, and on the 7th day all sludge-handling equipment is inspected and cleaned. Two tanks were constructed originally as concentration tanks, receiving sludge from the primary settling tanks; but in recent years better results have been obtained by simple aeration of the sludge in these tanks. After being aerated, the sludge is carried to the conditioning tank, where ferric chloride and lime are added and mixed for 10 min. The aeration appears to improve the handling of the heavy sludge.

Yeomans to Handle Aerofilter

Yeomans Bros., 1433 No. Dayton St., Chicago 22, Ill., have acquired a license to promote and sell the Aero-Filter (Halvorson-Smith) process of biological sewage treatment, using high capacity trickling filters. Already more than 100 of these plants have been installed. They are available in both single and multi-stage design, producing results comparable to those from low-rate filters that are seven or eight times as large. The aerofilter rounds out the Yeomans line of sewage treatment equipment, which now includes screening, scum and sludge handling equipment; clarifiers; digesters; sewage pumps; pneumatic sewage ejectors; mechanical aerators; and standard rate distributors.

(A complete treatment of the aerofilter will appear in an early issue in connection with the current series of articles on Trickling Filters. Ed.)

Sludge Pump Experiences

We have two Marlow Plunger Type Sludge Pumps. These pumps remove the sludge from the clarifiers to the digester tank. Their capacity is 40 gallons per minute and they are driven by a three horse power electric motor. Operation time totals about two and a half hours per 24 hour day.

These pumps have been operated for over ten years with only one breakdown with one of them. The pump cylinder on one pump broke from misalignment stress caused by the piston wearing to a taper. To keep it from leaking the operators kept tightening the gland. After getting the new cylinder we machined the piston to fit.

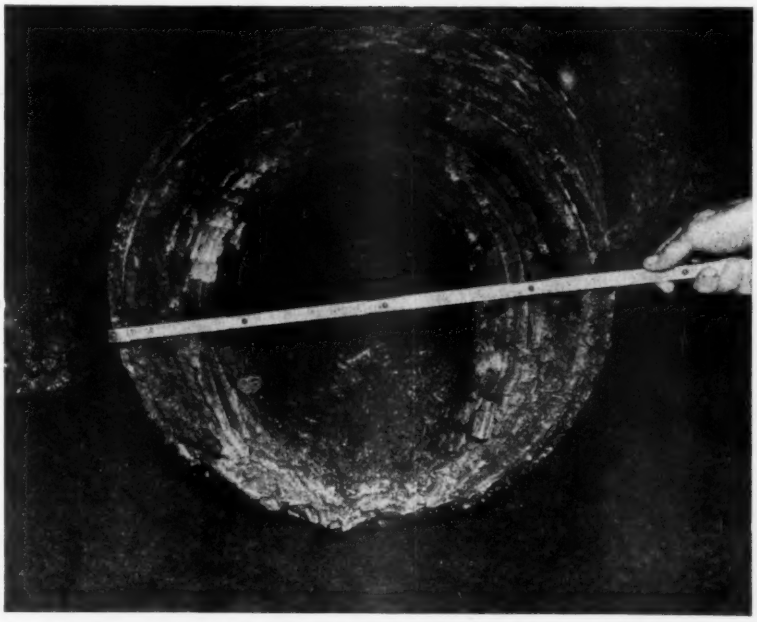
We used to use castor oil to lubricate the packing until this past year when we started using liquid soap. In my opinion this is by far the best for sludge pump lubrication in our set-up at Grand Forks.—John B. Kleven, Supt., Sewage Plant, Grand Forks, N. D., in a paper at the N. D. Water & Sewage Works Conf.

Water Works Data from St. Paul

The per capita use of water, as reported by the Water Commissioners of St. Paul, Minn., for the year 1945, was 92.7 gpc. The use per day per meter was 363 gals., and per line tap 402 gals. The unaccounted for water, with 99.9% of the services metered, amounted to 13.43% of the total. Domestic consumption amounted to 46.18% of the total, and commercial consumption 53.82%.

There were 646.99 miles of mains in use. Repair and maintenance cost, including hydrants and street work, was $50.62 per mile; maintenance cost per mile of main was $24.64 per mile. There were 5428 hydrants in use, or one for each 628 ft. of pipe. The average cost of maintenance per hydrant per year was $3.10. Valves in use on mains and services totaled 7595.

CANCER?



Cancerous conditions of pipe lines wear down pumping equipment, boost electric bills, create fire hazards and aggravate consumers with red water or loosened deposits.

A water system in this condition is as low in efficiency as a cancerous human system. As the medical profession has been trying for years to find a cure for human cancer, so has the pipe cleaning industry been trying to find ways and means to clean pipe at a fraction of its initial cost.

10 YEARS AGO

"Flexible" discovered a method that would remove even concrete from the interior without any possible injury to the pipe. Such conditions as shown in the above illustration were IMPOSSIBLE, but today a sizable amount of our work is of this nature. WRITE FOR ILLUSTRATED CIRCULAR TODAY.

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Booklets On Traffic Control and Parking Facilities

Municipal Provision of Parking Facilities—State Laws and City Projects. By James C. Yocum. This study contains a comprehensive analysis of state enabling legislation authorizing cities to deal with the parking problem. It shows the status of such legislation in all of the states as of the beginning of 1947. An outline of possible components of a *comprehensive* enabling law, amplified with examples of actual provisions selected from existing laws, is provided. A final section contains an analysis of the character of municipally-owned or sponsored parking facilities in operation or planned in a sampling of large and small cities in the United States.

Business Views on the Parking Problem in Ohio Cities. By James C. Yocum. This study summarizes the views of business groups in 48 Ohio cities of all sizes on methods of solving the parking problem. Ohio is one of the states which has no enabling legislation re municipal provision of parking. The attitudes of businessmen on the parking problem have been spontaneously generated out of mainly local experiences, hence their views as reported in this study are of particular interest.

Proceedings of the Third New England Traffic Engineering Conference. The proceedings of this conference, held to chart coordinated plans for meeting increasingly serious motor vehicle transportation problems, have been edited and published in book form by the National Conservation Bureau. The conference included discussions on pedestrian protection, traffic planning for cities, parking problems, and bridge and tunnel planning.

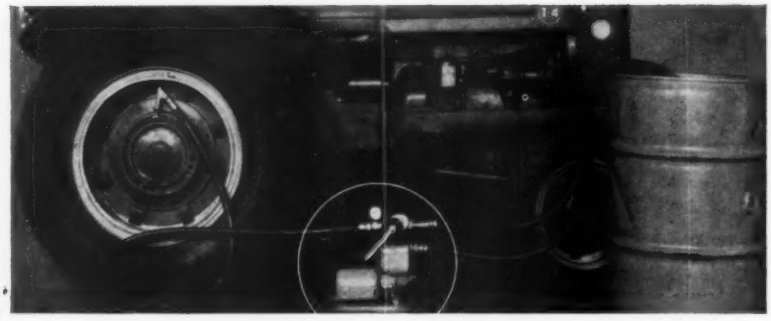
The Organization of Official Traffic Control Agencies. The Eno Foundation for Highway Traffic Control, Inc., Saugatuck, Conn.; 34 tables; 100 pages; no price given.

Each section of the report contains information about (1) names of traffic divisions; (2) titles of traffic heads; (3) persons to whom traffic heads report; (4) methods of appointing traffic heads; (5) salaries of heads of traffic activities in relation to salaries of other governmental department heads; (6) traffic functions; and (7) miscellaneous factors such as the ratio of police to population and traffic training. The materials on "functions" cover a wide range of traffic activities and are believed to represent those normally found in city and state departments.

Water Treatment

Conditioning of Water and Other Liquids. — Methods and apparatus for conditioning water and other liquids are described in a 60-page bulletin which has just been completed by Liquid Conditioning Corp. The company's executives who prepared the bulletin have had more than a quarter century of experience in this field, and have pioneered in many water treatment developments, such as hydrogen zeolite and demineralizing processes, sludge contact water softening and clarification equipment, higher-capacity zeolites, and also treatment of process liquids. The bulletin describes all types of water conditioning processes and explains the applications, advantages and limitations of each type. Included in the material specially developed for the bulletin are tables listing the various kinds of gaseous and solid impurities, showing the effects, limits of tolerance for various purposes, methods of removal and residual amount of each impurity after treatment; and also a comparison chart showing the chemical results produced by various water treatment methods. Illustrations show diagrammatically the principles of construction and operation of the various processes and equipment for softening, clarification and demineralizing of water and other liquids. Other tables and charts relating to water treatment add to the usefulness of the bulletin. Plant executives and engineers can obtain copies by writing on their company letterhead to Liquid Conditioning Corp., 423 West 126th Street, New York 27, N. Y., and asking for Bulletin G.

PUBLIC WORKS Equipment News



Gorman-Rupp tire-filler lightweight pump.

NoSpin Differential Available for Many Trucks

Detroit Automotive Products Corp., 8701 Grinnell Ave., Detroit, Mich., formerly Thornton Tamden Co., is now supplying 28 models of its differentials. These differentials can be installed in the 2-speed axles of Ford, Dodge, Fargo, International, Federal, GMC and Diamond T trucks, and also in the single speed axles of other popular trucks. They assure positive drive to both rear wheels, yet provide differential action with greater traction. *(Add to Chapter 1, Highway Manual)*

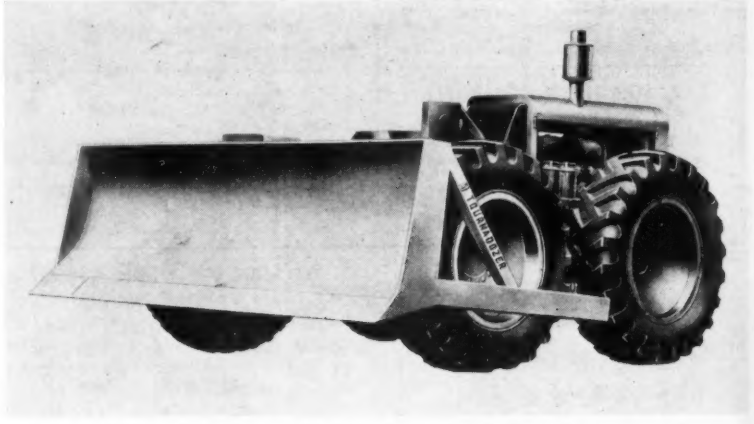
A Service Box for Permanent Water and Gas Service

Northshore Equipment Sales Corp., 60 Glen St., Glen Cove, L. I., has developed a service box for water and gas service. This box, called the Nesco, is of steel welded construction, of the telescopic type. The ground lock flanges are so placed that setting is accomplished quickly and with minimum labor cost. Frost heaving does not affect this service box, nor does any heavy downward thrust. Special coating prevents corrosion. This box can be used in place of any service box and can be furnished with or without rods for services up to 1¼-inch. Illustration shows typical box adjustable for 36" to 54" extension. Immediate shipment. *(Add to Chapter 2, Water Works Manual)*

Nesco Service Box.

Rubber-Tired Tournadozer for County and Similar Use

R. G. LeTourneau, Inc., Peoria, Ill., has announced the Model C Tournadozer, a rubber-tired earthmoving unit powered by a 160-hp. diesel. It has 4 forward speeds up to 12 mph., and the same in reverse. It is designed for the smaller jobs—road building, maintenance, backfilling, stockpiling, etc., and will handle from 184 yds. per hour on a 50-ft. haul, to 66 yds. on a 200-ft. haul and 35 yds. at 400 ft. It is hoped these will be available in distributors' showrooms in April. *(Add to Chapter 1, Highway Manual)*



New Tournadozer for maintenance, backfilling, etc.

Joint Sealing Compound in Colors

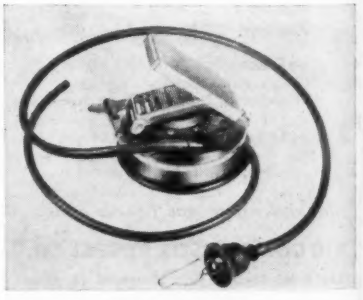
In addition to standard black, Para-Plastic joint sealing compound is now available in green, red, gray, cream and yellow. This material, which is adapted to the sealing of expansion joints in all types of concrete construction has been developed, after long experimentation, by Servicised Products Corp., 6051 West 65th St., Chicago 38, Illinois.

Gorman-Rupp Lightweight Pump

Gorman-Rupp Co., Mansfield, Ohio, has developed a new light-weight pump for filling tractor and construction equipment tires with liquid. This increases drawbar pull up to 60%. These pumps will evacuate the tire of liquid or air and then fill with water or calcium chloride solution. They are completely self-priming and 60-pound pressure capacity prevents overinflation.

Safe Drinking Water Anywhere

A pocket size filter plant is now available which will provide safe drinking water to small groups when an approved public water supply is not available. The device which gives this protection from water-borne disease is the very light "Mini-Filter," originally developed during the war. It includes a hand pump and filter together with



Compact "Mini-Filter."

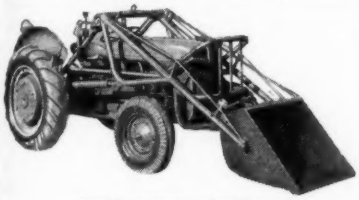
a purifying kit (Aqua-Tabs) all in a unit weighing less than five pounds. The principle of operation is the same as that used by municipal filter plants.

The Aqua-Tabs kit is a pocket-size unit that includes chemicals for purifying, testing and removing the "purified" taste from the water. It is an adaptation of a war-time kit used extensively to insure pure water for troops in the field.

The unit will be marketed through sporting goods dealers by Wallace & Tiernan, Belleville, N. J.

Loadtrac Tractor Loader

Loadtrac Co., 8 So. Michigan Ave., Chicago 3, Ill., makes a device that is attached to the rear axle and front mounting plate of a tractor and sits on the tractor. Installation takes only a few minutes with six bolts; no tractor alterations are required, and the hydraulic

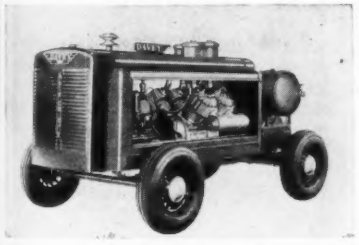


Loadtrac tractor loader.

system and power takeoff are left free for plow, scraper, scoop, or other device. The variety of work this device will do is described in a folder which will be sent on request.

160-Ft. Portable Air Compressor

Davey Compressor Co., Kent, O., is producing a new V-type 160-ft. air compressor, which has 3 low and one high-pressure cylinders. This new model is available in skid, steel-wheel or pneu-



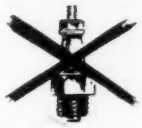
160-ft. Davey compressor.

matic-tire trailer mounting. There are many other features contributing to good operation, which are described in a folder which will be sent on request.

Flexible Tee Coupling for Easier Installation of Laterals

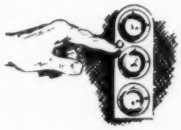
Smith-Blair Co., South San Francisco, Calif., has developed a flexible tee coupling for sizes from ¾-inch through 2-inch. This eliminates the need for field threading of pipe in the trench, does away with couplings, nipples and unions and saves time and expense. It greatly simplifies house connections to existing pipe lines.

I Never Knew Diesel Power Could be so Simple to Operate



MY SHEPPARD *is a full diesel ... has no distributor, coil or spark-plugs that need attention and care. Rain won't stop it.*

THE SHEPPARD *Diesel operates and starts on common furnace oil, injected in a solid spray. There is no temperamental carburetor to adjust and maintain.*

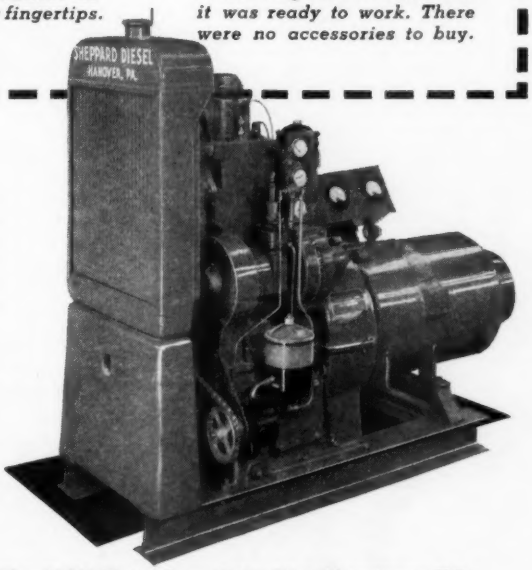


I SET *the throttle ... push a button ... and my Sheppard is running. Dependable power ... free from all outside interference is at my fingertips.*

MY SHEPPARD *Diesel was delivered complete. I just put it in place, supplied it with fuel, lubricating oil and water and it was ready to work. There were no accessories to buy.*

Write for the illustrated booklet that completely explains many other outstanding advantages of Sheppard Diesel power units and generating sets.

R. H. SHEPPARD CO., INC.
50 Middle St., Hanover, Pa.



Sheppard DIESEL

Generating Sets—2,000 to 36,000 Watts • Power Units—3¾ to 56 continuous H.P.

DIESEL'S THE POWER ...

Sheppards' the Diesel

When writing, we will appreciate your mentioning PUBLIC WORKS

3-Cu. Ft. Kinetic Asphalt Mixer

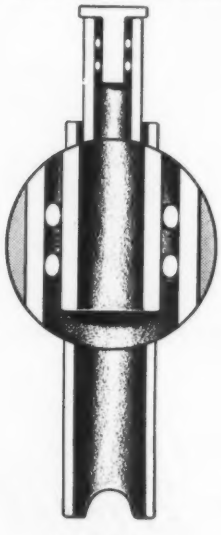
The Foote Co., Inc., Nunda, N. Y., has developed a 3-cu. ft. mixer to handle all types of cold asphaltic mixes, including sheet asphalt and asphaltic concrete types. A new mixing principle provides a thorough coating of all aggregate particles with asphalt, making possible in this small unit the use of chemical additives to eliminate the need for drying wet aggregates. Under good conditions,

Foote Asphalt Mixer.

this unit will operate at the rate of 2 batches per minute. Asphalt is introduced by a pump at the maximum rate of 8 gallons in 6 seconds; an automatic timer closes the control valve when the desired gallonage has been added. Weight is 1500 lbs.; power is from a 12 hp. engine or electric motor; an adjustable truck hitch is provided for transportation. *(Add to Chapter 6, Highway Manual)*

A Shock-Proof Curb Service Box

Pilot Engineering Service, 3804 North Fratney St., Milwaukee, Wis., makes a curb service box of fibre pipe construction, which is designed to absorb all surface shocks. It is light in weight and easy to install; lengths and sizes are available for all grade conditions and for prompt delivery. *(Add to Chapter 2, Water Works Manual)*



Pilot Curb box.

Wire Cord Tires for Heavy Duty

Heavy duty tires in which strands of high tensile steel wire have been substituted for conventional cotton and rayon cord are now in production by the Firestone Tire and Rubber Company. These tires are especially designed for rugged duty on construction and other operations where trucks and equipment must serve under severe, off-the-highway conditions. Advantages claimed are (1) high sustained strength under higher temperatures, (2) negligible stretch under load, (3) the ability, as a result of greater conductivity of the wire construction, to dissipate heat away from the normally vulnerable points. It is stated that the wire cord tire will stand several retreads. Repairs can be made by conventional methods, using standard patches and materials.

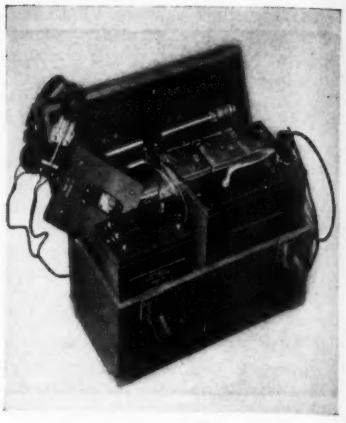
Sand, Cinder and Dust Control Spreader

Highway Equipment Co., Inc., Cedar Rapids, Ia., has developed a new spreader, which is of the distributor disc type. Material is cast ahead of the rear wheels of the truck, providing traction, and spread can be controlled to cover the full width of a 2 or 4-lane roadway. All controls are in easy reach of the driver's seat. By removing the spreader disc, the unit can be used for hauling material, and it is easily adapted to hauling and spreading chips and broken stone for shoulder maintenance. Built in four lengths to mount on any truck chassis, the unit is driven by a power takeoff. *(Add to Chapter 6, Highway Manual)*

Sand, cinder and chip spreader.

Ozalid Streamlined Reproduction Machine

This machine is claimed to reproduce anything drawn, typed, printed or photographed on translucent material, producing a positive copy. No intermediate steps are required; no chemical baths or inks are used; and prints are delivered dry and ready for use. There are only two operations—exposure and dry development. It is claimed to take only 25 seconds; and that an 8½ x 11 reproduction costs one cent. Lines can be reproduced in color. The unit requires 11 sq. ft. of space. Write for fuller information to Ozalid, Johnson City, N. Y.



Compact Wahlquist cable locator.

Pipe and Cable Locator

The "Wahlquist" Pipe and Cable Locator, a product of Nilsson Electrical Laboratory, Inc., New York 13, N. Y., provides means of locating hidden pipes, cables or other conductive substructures. The Model 113 (see cut) consists of a transmitter, receiver, headphones, batteries and leads, all housed in a carrying case. The interrupted signal feature of the transmitter will enable test tone to be distinguished over power noise where necessary. The set is compact in size and light in weight, the transmitter and receiver weighing only 4 lbs each. *(Add to Chap. 10, The Water Works Manual)*

Pedestal Type Pumps, 10 gpm to 500 gpm.

Allis-Chalmers Mfg. Co., Milwaukee, Wisc., announces a new line of cast iron bronze-fitted, pedestal-type centrifugal pumps in three principal sizes—1" x 1", 2" x 2" and 3" x 3". Capacities are from 10 to 500 gallons per minute at heads from 10 to 100 feet with power requirements from ¼ to 15 horsepower.

These "Pedrifugal" pumps are expressly designed for use with Texrope V-belt drives, giving an infinite range of capacities regulated by size of sheaves and power supplied. All the pumps are fitted with impellers of maximum diameter, and variations in capacity are provided by changes in speed.

PERSONAL AND BUSINESS

A. S. Behrman has announced the establishment of a chemical consulting practice, specializing in the fields of water treatment, ion-exchange processes, siliceous gels and gel catalysts, and chemical patents. Office and laboratory are at 9 South Clinton St., Chicago.

George W. Kelsey has been named a Vice President of Builders Iron Foundry, Providence, R. I. Mr. Kelsey was formerly General Sales Manager of this concern.

Albright & Friel, Inc., consulting engineers, have removed their offices to Suite 816-822, 1528 Walnut St., Philadelphia 2, Pa., where they will continue their engineering practice.

Liquid Conditioning Corporation of Linden, N. J., manufacturers of equipment and material for water softening and clarification, have appointed Engineering Sales Corporation of Boston, Mass., as its New England representative.

L. O. Keener, formerly Assistant Superintendent of Highways for Westmoreland County Commissioners, Pa., has become a member of the technical staff of the Clay Sewer Pipe Association. Mr. Keener will maintain headquarters at Greensburg, Pennsylvania.

John C. Painter has been appointed District Representative of The Galion Iron Works & Mfg. Co., manufacturers of rollers and motor graders. He will cover the states of North Carolina, South Carolina, Florida, and Georgia.

James B. Clow and Sons have announced the purchase of the Iowa Valve Company. Production will be continued under the same name. A. W. Read will remain with the company as Vice President and General Manager, and will be assisted by Iver Read. J. W. Dousette will continue as General Sales Manager. New officers of the company are K. S. Clow, President; G. P. O'Day, Vice President; and E. F. Johnson, Secretary-Treasurer.

Dr. Frederich G. Whelan, an electrical engineer, and *Ralph F. Vaccaro,* a bacteriologist-chemist, have joined the staff of the Sanitation Research Project, Association of American Railroads, of which Dr. Abel Wolman is consultant and Col. L. K. Clark Project Director.

NEW BOOKLETS

Meter repair and testing is described in a 16-page booklet by the Neptune Meter Company, 50 West 50 Street, New York 20, N. Y. Contents describe (1) what is needed to set up a planned meter repair program; (2) layout of a meter shop; and (3) step-by-step repair instructions.

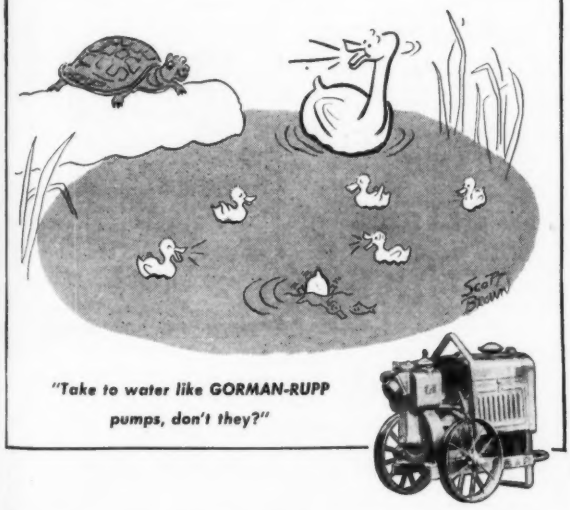
Parabolic Flume.—The Type S parabolic flume for measuring open flows of water, sewage or other liquids is described in Bulletin 210, 8 pp. Simplex Valve & Meter Co., 68th and Upland Sts., Philadelphia 42, Pa.

Construction Booklet.—Useful information on constructing foundations and basements, laying floors, surfacing interior and exterior walls, protecting exposed structural members, etc. Write Stonhard Co., 883 Terminal Commerce Bldg., Philadelphia 8, Pa.

Wheel Tractors.—A 24-page catalog of wheel tractors, their uses and the equipment for use with them. Three models burn gasoline, kerosene or distillate; two models are diesel powered; and there is one light tractor gasoline powered for highway mowing. International Harvester Co., 180 No. Michigan Ave., Chicago 1, Ill.

Road Repair Equipment — A folder illustrating and describing tar and asphalt kettles, spray tanks, patching rollers and emulsion sprayers. Write Littleford Bros., Inc., 452 East Pearl St., Cincinnati 2, Ohio.

Couplings for Pipe.—A 106-page catalog contains a full description of every Dresser product. It illustrates 36 principal pipe joining and repair products, with descriptions of their uses. Includes gasket information and tables of useful information. A fine addition to your library. Dresser Mfg. Co., Bradford, Pa.



"Take to water like GORMAN-RUPP pumps, don't they?"

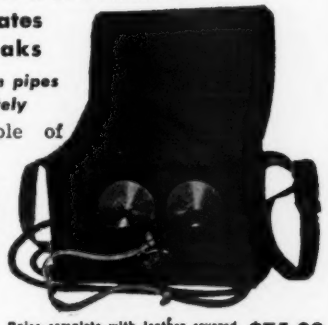
Order a Gorman-Rupp Self-Priming, Centrifugal Pump from your distributor, put it on the job for thirty days. If it isn't the best pump you ever used we will take it back and it won't cost you a cent.

THE GORMAN-RUPP COMPANY
MANSFIELD • OHIO

STOP YOUR LEAKS *with*
GLOBE GEOPHONE
REGISTERED U. S. PATENT OFFICE

The ear that locates underground leaks
in water, air and steam pipes quickly and accurately

Operates on principle of Seismograph. Simple. Dependable. Often its use on one leak saves its cost. In successful use for 25 years. No water system can afford to be without it.



Price complete with leather covered carrying case and shoulder strap $75.00

LITTLE WONDER PIPE PHONE
Every service man needs one of these

Price complete with carrying bag $3.70

Very efficient for testing valves, checking leaks—water or steam—inside buildings. Tells if water left running in vacant premises through faucets, leaky closets, etc.

For descriptive folder and more detailed data, write
GLOBE PHONE MFG. CORP. DEPARTMENT P READING, MASS.
Original Manufacturers of GLOBE GEOPHONES
Manufacturers of Geophones since 1918

Preco to Manufacture Reflecting Elements

Announcement has just been made in Cincinnati of the formation of the Preco Manufacturing Company and Preco, Incorporated. These companies have been organized to resume an operation which was curtailed in 1941 because of the freezing of aluminum for war use. Their principal business will be to manufacture and sell Preco Reflecting Elements which are used mainly for warning signs and for day and night advertising reflecting signs.

B. W. Brink

The reflecting elements are produced from a highly polished aluminum surface, protected by an oxide of aluminum surface, which gives many years of life without losing any of its reflectivity. This reflector sheet is then indented with a patent indentation which gives it greater angular reflectivity than heretofore accomplished.

The officers of the Preco Manufacturing Co. are B. W. Brink, president; Ira S. Holden, vice-president; T. B. Zumstein, secretary and treasurer; Harold Smith, chemist and engineer; and F. J. Parrillo, engineer and designer. The company is moving into a large plant at Bridgetown Road and Karen Ave., in suburban Cincinnati. Offices are located at 628 Sycamore St., Cincinnati, Ohio.

International Harvester Reduces Prices

International Harvester Co., 180 North Michigan Ave., Chicago, Ill., has announced price reductions on 163 basic models of tractors, motor trucks, industrial power equipment and farm machines. In the public works field, reductions were made on 16 models of industrial tractors and engines, on 12 models of trucks, and on certain motor truck attachments. Reductions ranged from 1% to 23.8%. On motor trucks these ranged from $50 to $300; on crawler tractors from $35 to $50; on power units from $10 to $150; and on wheel tractors from $19 to $56.

The Dorr Company has sold its interest in the Electro Rust-Proofing Corporation of Belleville, N. J., to Wallace & Tiernan Co., Inc.

John T. Woodson has been appointed sales representative for the Hydraulic Development Corporation, 50 Church Street, New York, for Virginia and the Carolinas, with headquarters in the Independence Building, Charlotte, N. C. Mr. Woodson is widely known to the waterworks fraternity, having been for over 20 years sales manager for the Lynchburg Foundry Company, and later southern sales manager for the National Cast Iron Pipe Division, Birmingham, Ala.

John T. Woodson

SAVE Time! SAVE Labor!

REDUCE Expense!

"Just socket the spigot and calk"

It's EASY to lay century-lasting 2" Mains with McWane PRECALKED Pipe.

One man with a calking tool and a hammer can do the job quickly and easily . . . for all he does is "socket the spigot and calk!" No lead to melt and pour! No expensive equipment! No skilled labor! Installation time cut! Costs reduced.

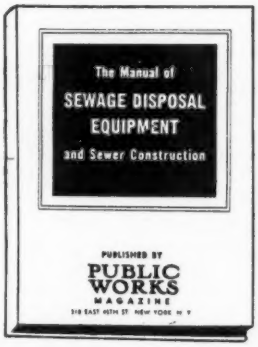
USE McWANE CAST IRON PIPE

McWane Cast Iron Pipe Co., Birmingham 2, Ala.

McWane PRECALKED Pipe

Announcing a New

COMPLETELY REVISED EDITION



A great help in working up plans for sewage disposal

The new 1946-47 edition of The Sewerage Manual is now off the press. This new Manual describes every type of equipment and material available for use in sewage disposal and sewer construction. It is used by leading sanitary engineers everywhere when preparing plans. It is the standard source of unbiased information.

Write today for information on how to be one of the first to obtain a copy of this valuable Manual.

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USE THIS COUPON

CONSTRUCTION MATERIALS AND EQUIPMENT

Data on All Types of Bins and Batching Plants

11. Good illustrations and useful data on all types of Heltzel Highway Bins, for truck mixer charging, bulk cement plants, enclosed bucket elevators, belt conveyors, etc. Heltzel Steel Form & Iron Co., Dept. P.W., Warren, O.

Self-Propelled Crane for Every City-County Need

20. Here's a fast, versatile industrial crane with plenty of lift . . . gets there in a hurry on ruober tires . . . one man operates it easily . . . 5 ton capacity—7 ton with outriggers. Send for bulletin PW, Unit Crane & Shovel Corp., 6323 West Burnham St., Milwaukee 14, Wisc.

Truck-Mounted Loader Travels Fast, Loads Quickly

22. New Eagle Truck-Mounted Loader, operated by truck driver, goes from job to job at truck speed. Loads all kinds of material quickly. No costly working parts. Ask for new bulletin PW. The Eagle Crusher Co., Inc., Galion, Ohio.

How to Make More Durable Concrete at Low Cost

50. How cement dispersion assures improved concrete with impressive economies in initial construction costs and maintenance costs. Manual from The Master Builders Co., Dept. P.W., 7016 Euclid Ave., Cleveland 3, Ohio.

Solve Your Drainage Problems This Easy, Permanent Way

70. Useful new 60 page catalog on standard corrugated pipe, multi-plate pipe and arches and 18 other drainage and related products for culverts, sewers, subdrains, flood control, airports, water supply and other types of construction. Ask for "Armco Products for Engineering Construction," Armco Drainage and Metal Products, Inc., Dept. PW Middletown, Ohio.

Handle All Kinds of Tough Grading Jobs Economically

98. The Austin-Western 99M Power Grader with its powerful all wheel drive handles difficult jobs with economy and efficiency; and does better work on grading, ditching, scarifying, snow ploughing, loading, mixing, bulldozing, shoulder trenching and backsloping. Write for Bulletin 1946. Dept. P.W., Austin-Western Co., Aurora, Ill.

One Man Operates This Self-Contained Gas Hammer

110. Powerful self-contained gasoline hammers illustrated in new booklet. Used as paving breakers and spike drivers. Easily portable, economical. Write Syntron Co., 660 Lexington, Homer City, Pa.

Methods of Installing Steel Sheet Piling

112. Illustrated descriptions of both standard and interlock corrugated steel sheet piling of minimum weight, maximum strength, ease of handling with methods of installation are contained in a booklet. If you have a job involving piling write Caine Steel Co., Dept. P.W., 1820 N. Central Ave., Chicago 39, Ill.

Reliable Every Purpose Pumps

117. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

Got an Earth Moving Problem?

126. Write Gar Wood Industries, Dept. P.W., Wayne, Mich., on their Two and Four Wheel Scrapers, Bulldozers, Tamping Rollers, Winches, Hoists and Repair Towers.

"Dieselectric" Plants for Low-Cost Light and Power

392. 20-page catalog P.W. describes "Dieselectric" plants 3 to 10 KVA, and diesel engines from 4 to 12 H.P. These are easily transported and will produce reliable, low cost light and power anywhere. Write WITTE ENGINE WORKS, Division of Oil Well Supply Company, Kansas City 3, Mo.

One to Two H.P. Air Cooled Engine for Dependable Power

523. New bulletin illustrates many uses for Clinton 1 to 2 H.P. gasoline engines. Gives full specifications and power data. An economical, long lasting power unit. Write Dept. PW, Clinton Machine Co., Clinton, Mich.

Briggs and Stratton 4-Cycle Air Cooled Engines

524. Tested under severest conditions of long, hard use, these engines have earned world wide recognition as the "night" power for hundreds of applications. Get latest bulletin from Dept. PW, Briggs and Stratton Corp., Milwaukee 1, Wisc.

Data and Pictures of Complete Line of New Ford Trucks

532. Full line of new Ford Trucks for 95% of all hauling needs is pictured in colorful circular—Light Duty, One-Ton, Heavy-Duty and C. O. E. trucks. Also 48 out of over 100 standard, factory built chassis and body combinations. See before you buy. Write for your copy now. Truck and Fleet Sales Dept., Ford Motor Co., Dearborn, Mich.

Practical Portable Power Units for Every Need

533. M-M power units with heavy duty engine, positive lubrication, easy servicing, handy controls may be just what you have been looking for. Simple, durable, practical. Get latest bulletin from Dept. PW., Minneapolis Moline Power Implement Co., Minneapolis 1, Minn.

SNOW FIGHTING

For High-Speed Snow Removal

350. "Frink One-Way Sno-Plows" is a four page catalog illustrating and describing 5 models of One-Way Blade Type Sno-Plows for motor trucks from 1½ up to 8 tons capacity. Interchangeable with V Sno-Plow. Frink Sno-Plows, Inc., Clayton, 1000 Islands, N. Y.

Fast, Efficient Skid-Proofing

355. Get full facts about Baughman Light-Weight Cinder Spreaders, fast operators for cinders, sand, salt, chips, etc. Free flowing at low temperatures. 9-17 cu. yd. cap. Write Dept. P.W., Baughman Mfg. Co., Inc., Jerseyville, Ill.

STREETS AND HIGHWAYS

Expansion Joint Fillers for Highways, Dams, Bridges, Etc.

102. Kork-Pak fiber joint, Premoulded Asphalt Joint, Non-Extruding Cork Joint, Self Expanding Joint for use on Highways, Dams, Bridges, Tunnels and General Construction. Bulletin describing and illustrating these joints sent on request to Servicised Products Corp., 6051 West 65th St., Chicago 38, Ill.

Levels Sidewalks and Curbs Quickly and Easily

107. How the Mud-Jack Method for raising concrete curb, gutter, walls and streets solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee 10, Wis.

Speed Your Work With These Powerful Motor Graders

128. Two powerful Galion motor graders designed to answer every requirement for more speed in road, airport, dam and housing construction work are fully described in a folder illustrated with many action pictures. Issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

Tandem, 3 Wheel and 3 Axle Road Rollers

138. "The Buffalo-Springfield" line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog P.W. issued by the Buffalo-Springfield Roller Co., Springfield, Ohio.

Here's a Roller for Every Need

141. Three-Wheel and Tandem Rollers, 5 to 8-ton and 10 & 12 ton sizes: also variable weight tandem roller for new highway surfacing and old road conditioning. Ask for new bulletin. Dept. P.W., Huber Mfg. Co., Marion, Ohio.

Want High-Service Low-Cost Roads?

150. "High-Service, Low Cost Roads" sets forth the principles and advantages of road surface stabilization with calcium chloride. Complete, interesting and well illustrated, 34 pages. Sent by Solvay Sales Corp., Dept. P.W., 40 Rector St., New York 6, N. Y.

Looking Into Soil Stabilization?

154. "Soil Stabilization with Tarvia"—An illustrated booklet describing the steps in the stabilization of roadway soil with Tarvia will be mailed on request by Dept. P.W., The Barrett Division, 40 Rector St., New York 6, N. Y.

Mix-in Place Roadbuilders Save on Scarce Labor

187. Mix-in Place Roadbuilders. Bituminous Pavers, Concrete Bituminous Finishers. Adjustable Spreaders, Forms, etc. —4 complete catalogs in one cover, issued by the Jaeger Machine Company, 400 Dublin Ave., Columbus 16, Ohio.

Here's Your Diesel Tractor!

190. Big 48 page catalog describes and lists many uses for International Diesel Tractors. Write International Harvester Co., Dept. P.W., 180 North Michigan Ave., Chicago 1, Ill.

Latest Maintenance Equipment For Blacktop Roads

290. "Blacktop Road Maintenance and Construction Equipment" — Asphalt and tar kettles, flue type kettles, spray attachments, tool heaters, surface heaters, road brooms and rollers. This is modern and up-to-date equipment for blacktop airport and road construction and maintenance. Write for Catalog R. Littleford Bros., Inc., 452 East Pearl St., Cincinnati 2, Ohio.

Special Truck Bodies for Every Municipal Need

375. Gar Wood special bodies for sanitary refuse collection are illustrated and described in a new catalog issued by Gar Wood Industries. Dept. P.W., Wayne, Mich.

Mow Clean and Fast In Tight Corners

510. Send for latest literature about the Cunningham Mower for Fence Rows, Parking Areas, Driveways, Picnic Grounds and many other jobs. 3 ft. cut, variable speed, rugged, easy to handle. James Cunningham, Son & Co., Dept. 16, 13 Canal St., Rochester 8, N. Y.

All Purpose Spreader Spreads 2 to 10 ft. Wide

514. Saves labor, spreads 0 to 100 lbs. a sq. yd., dust up to 1" material, forward, reverse, on curves, hills or straightaway. Assures uniform, even density of spread. Write for bulletin: Dept. PW, All Purpose Spreader Co., Fuller Rd., Elyria, Ohio.

SEWAGE DISPOSAL

Non-Corrosive, Long Lasting Low Cost of Sewer Pipe

72. Get this new engineering data on clay pipe for sewers. Withstands acid, alkali and gas attacks indefinitely. Cuts maintenance costs to a minimum. Write Dept. P.W., National Clay Pipe Mfrs., 111 W. Washington St., Chicago 2, Ill.

Valuable Booklet on Porous Diffuser Plates and Tubes

367. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability, 20 pp. illustrated. Write to Norton Company, Dept. P.W., Worcester 6, Mass.

It's No Trick to Clean Sewers This Modern Way

386. 32-page illustrated booklet explains how a city can clean its sewers and culverts with its own forces using the up-to-date Flexible Sewer Rod equipment. Illustrates and describes all necessary equipment. Issued by Flexible Sewer Rod Equipment Co., 9059 Venice Boulevard, Los Angeles 34, Calif.

How Cities Can Do Complete Sewer Cleaning From Street

387. Literature illustrating how cities, towns and villages using OK Champion Sewer Cleaners are doing a complete sewer cleaning job from street level. Three sizes of machines available in addition to full line of sewer rods and accessories. Issued by Champion Corporation, 4752 Sheffield Avenue, Hammond, Indiana.

All About Flow Meters

409. The primary devices for flow measurement—the orifice, the pitot tube, the venturi meter and others—and the application to them of the Simplex meter are described in a useful 24-page booklet (No. 300). Simplex Valve and Meter Co., 8750 Upland St., Philadelphia 42, Pa.

Make Low-Cost Electricity From Cheap Fuel

422. New booklet describes Sheppard Diesel Generating Sets that make low cost electricity from cheap fuel and give dependable service in the hands of any average operator. Write R. H. Sheppard Co., 250 Middle St., Hanover, Pa.

Need Street, Sewer or Water Castings?

429. Street, sewer and water castings in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog P.W. issued by South Bend Foundry Co., Lafayette Boul. and Indiana Ave., South Bend 23, Ind.

How to Select Main Line Meters

432. New bulletin illustrates Builders Air Relay system for liquids containing suspended solids like sewage. Eliminates corrosion, clogged pipes, etc. "The Selection of Main Line Meters," a highly informative and useful presentation, describes forms of differential producers and quickly solves typical problems with the use of graphic charts. Write Builders-Providence, Inc., Dept. P.W., 9 Codding St., Providence 1, R. I.

How to Make Better Sewer Pipe Joints

447. How to make a better sewer pipe joint of cement—tight, minimizing root intrusion, better alignment of joint. Permits making joints in water-bearing trenches. General instructions issued by L. A. Weston, Dept. P.W., Adams, Mass.

Save Trucks and Labor In City Rubbish Collection

459. For saving trucks, labor, and time in city rubbish collection get details of the new Dumpster-Kolector described in literature just published by Dempster Brothers, Inc., 996 Higgins, Knoxville 17, Tenn.

How to Get Automatic Removal of Screenings

460. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and inclined types). Link-Belt Co., Dept. P.W., 2045 W. Hunting Park Ave., Philadelphia 40, Pa.

An Incinerator Necessity

463. Recuperator tubes made from Silicon Carbide and "Fireclay" Corebusters for maximum efficiency are described and illustrated in bulletin No. 11 issued by Fitch Recuperator Co., Dept. P.W., Plainfield National Bank Bldg., Plainfield, N. J.

How Nichols Incinerator Disposes of Sewage Solids

464. Nichols Herreshoff incinerator for complete disposal of sewage solids and industrial wastes—a new booklet illustrates and explains how this Nichols incinerator works. Pictures recent installations. Write Dept. PW, Nichols Engineering and Research Corp., 60 Wall Tower, New York 5, N. Y.

Ask for This Design Data On Sprinkling Filters

469. Design data on sprinkling filters of Separate Nozzle Field and Common Nozzle Field design as well as complete data on single and twin dosing tanks, and the various siphons used in them, for apportioning sewage to nozzles. Many time-saving charts and tables. Write Pacific Flush Tank Co., Dept. P.W., 4241 Ravenswood Ave., Chicago 13, Ill.

Useful Design Data on Sedimentation Tanks

482. "Sedimentation with Dorr Clarifiers" is a complete 36-page illustrated catalog with useful design data. Ask The Dorr Company, Dept. P.W., 570 Lexington Ave., New York 22, N. Y.

Packaged Sewage Treatment— Just Right for Small Places

488. "Packaged" Sewage Treatment Plants specifically developed for small communities — 100 to 3,000 population. Write for full description and actual operating data for this type of plant. Chicago Pump Co., 2348 Wolfram St., Chicago 18, Ill.

POWER PLUS!
THAT'S SYNTRON

100% SELF-CONTAINED
Gasoline Hammer
PAVING BREAKERS
Save Time for Your Men
Save Money for You

BUSTING Concrete
CUTTING Asphalt
DIGGING Clay and Shale
TAMPING Backfill—and a host of other jobs.

Write for Illustrated Folder
SYNTRON CO., 660 Lexington, Homer City, Pa.

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Look Into This Sewage Treatment Equipment

490. New bulletin P.W. fully describes and illustrates Hardinge sludge collectors for clarifiers, sludge concentration and skimming in both circular and rectangular tanks. Write Dept. P.W., Hardinge Company, Inc., York, Pa.

Need Equipment for Small Sewage Plant?

491. Small type Conveyor Sludge Collector and Skimmer, Grit Collector, Aero-Filter and other equipment for small sewage treatment plants are described and illustrated in bulletins from Chain-Belt Co., 1722 West Bruce St., Milwaukee 4, Wis.

Glazed Clay Blocks for Trickling Filter Underdrains

492. Illustrated bulletin describes the Natco Unifilter block of glazed, hard burned clay for underdraining filter beds. Write National Fireproofing Corp., Pittsburg 12, Pa., for free copy.

How to Use Alum for Coagulation

502. Alum for coagulation in both sewage and water plants is the subject of literature now available from Dept. P.W., General Chemical Company, 40 Rector St., New York 6, N. Y.

Engineering Details of Armcre Filter Blocks

525. Engineering bulletin shows construction details of Armcre Filter Bottom Blocks for better trickling filter results. Tells how Armcre blocks meet all requirements. Write to Ayer-McCarel-Reagan Clay Co., Brazil, Ind.

For Completely Successful Trickling Filter Systems

526. Armcre Filter Bottom Blocks by BOSCO. 12-page illustrated booklet explains how Armcre blocks meet every requirement for successful trickling filter operation. Gives full specifications and construction details. Includes use for Bio-Filtration. Write Bowerston Shale Co., Bowerston, Ohio.

One-Unit and Two-Unit Vitrified Floor Systems

527. Metro one-unit and two-unit vitrified clay blocks for trickling filter floors are described in illustrated catalog. Includes construction drawings, pictures and complete specifications. Ask for your copy today. The Metropolitan Paving Brick Co., Canton, Ohio.

All About Translot Filter Bottom Blocks

528. Illustrated Engineering Bulletin gives full data about Translot Filter Blocks for Trickling Filters. Shows typical sections, installation views, etc. Write Cannelton Sewer Pipe Co., Cannelton, Ind.

For All Sludge Dewatering

601. The first filters to be used in large scale operation on primary, elutriated and Guggenheim sludges. Ask for latest engineering Bulletin P.W. General American Process Equipment Div., 10 E. 49th St., New York, N. Y.

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602. All interested in low cost air for sewage disposal will want a copy of this useful booklet. Describes operating principles and specifications of Roots-Connersville Aerating Blowers. Write to Roots-Connersville Blower Corp., 301 Valley Ave., Connersville, Ind.

WATER WORKS

How to Analyze Water

360. "Methods of Analyzing Water for Municipal and Industrial Use" is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., Dept. P.W., 40 Rector St., New York 6, N. Y.

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388. Literature on Flexible method of cleaning water mains any size from 2" to 72", giving full details and list of nearest representatives in all parts of country. Address: Flexible Underground Pipe Cleaning Co., 9059 Venice Blvd., Los Angeles, Calif.

Solve Corrosion Problems With This Special Alloy

391. "Everdur Metal" is title of an 8-page illustrated booklet describing advantages of this corrosion-resisting alloy for sewage treatment equipment, reservoir, and waterworks service. Dept. P.W., the American Brass Co., 25 Broadway, N. Y. C.

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397. Everson SterElators. Bulletins 1063, 1066, 708 and others describe this device for measuring, mixing and feeding chlorine or other gases in solution. Capacities range from ¼ lb. to 2,000 lb. of gas per 24 hours. Address: Everson Manufacturing Co., 214 W. Huron St., Chicago 10, Ill.

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407. Hydrants and Valves. Catalog P. W. covers fire protection appliances, including hydrants, gates and check valves. Catalog also describes sluice gates, shear gates, and flap, mud, gate, check and foot valves. Address: Mueller Company, Chattanooga, Tenn.

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88 Page Book Helps Solve Water Problems

423. pH and Chlorine Control. A discussion of pH control and description of comparators, chlorimeters and similar devices. An 88-page booklet. W. A. Taylor & Co., 7304 York Road, Baltimore 4, Md.

It's Easy to Use This Leak Locator

426. Leak Locators. Again available to waterworks superintendents, the Globe line of leak locators, dipping needles and pipe finders. Several leaflets describing the original Geophone leak locator, Little Wonder pipe phone, and the Magnetite Dipping Needle. Globe Phone Mfg. Corp., Dept. P., Reading, Mass.

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436. Handbook of Universal Cast Iron Pipe and Fittings, pocket size. 104 pages, illustrated, including 14 pages of useful reference tables and data. Sent by The Central Foundry Co., Dept. P.W., 386 Fourth Ave., New York 16, N. Y.

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438. "Cast Iron Pipe and Fittings" is a well illustrated 44 page catalog giving full specifications for their complete line of Sand Spun Centrifugal Pipe, Fire Hydrants, Gate Valves, Special Castings, etc. Will be sent promptly by R. D. Wood Co., Dept. P.W., Public Ledger Building, Independence Square, Philadelphia 5, Pa.

How to Make Concrete Pipe on the Job

440. Making concrete pipe on the job to give employment at home is the subject of a booklet sent on request by Quinn Wire & Iron Works, 1621 12th St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms.

Concrete Pipe With Greater Elasticity

442. Lock Joint Reinforced Concrete Sewer Pipe, Pressure Pipe, Culvert Pipe, Centrifugal Pipe and Subaqueous Pipe is described and illustrated in bulletins available from Lock Joint Pipe Co., Ampere, N. J.

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445. Two new illustrated booklets, "Transite Pressure Pipe" and "Transite Sewer Pipe" deal with methods of cutting costs of installation and maintenance of pipe lines and summarize advantages resulting from use of Transite pipes. Sent promptly by Johns-Manville Corp., Dept. P.W., 22 East 40th St., New York 16, N. Y.

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474. Technical pub. No. P.W. 207 issued by Wallace & Tiernan Co., Inc., Newark 1, N. J., describes in detail taste and odor control of water with BREAK-POINT Chlorination. Sent free to any operator requesting it.

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481. Installation-tested equipment for complete municipal and industrial systems or individual units. Illustrated and described in latest booklets from Dept. P.W., American Wells Works, Aurora, Ill.

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498. Engineering Bulletin describes stabilizing lime-softened water by recarbonation, discusses gas production, washing, compressing, drying, and applying the CO (2). Infilco, Inc., 325 West 25th Place, Chicago 16, Ill.

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506. Data on anti-freeze outdoor drinking fountains, hydrants, street washers, etc., contained in Catalog L. Sent promptly on request to Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati 2, Ohio.

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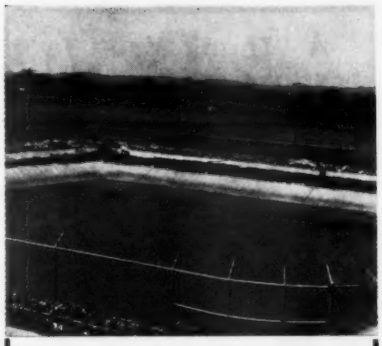

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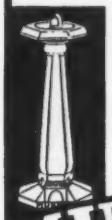

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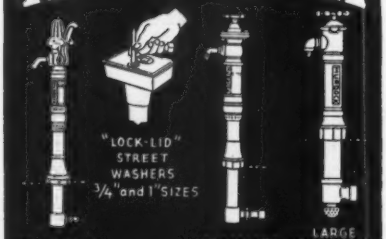
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Chlorine and Soda Ash.—Two of the handy booklets on chemicals issued for your information and use. Write Columbia Chemical Division, Pittsburgh 13, Pa.

NEWS OF ASSOCIATIONS

A meeting of the *Pennsylvania Water Works Operators' Association* will be held at Morrisville, N. J., May 8.

The *American Water Works Association* and the *Federation of Sewage Works Associations* will hold their annual conventions concurrently at the San Francisco Civic Auditorium, July 21 to 25.

The *Maryland-Delaware Water and Sewage Association* will hold its annual convention May 15th and 16th at the Hamilton Hotel, Washington, D. C.

"The Control of Plants Detrimental to Health" will be the subject of six meetings conducted by New York University. Methods of control and organization of municipal weed-elimination programs will be covered.

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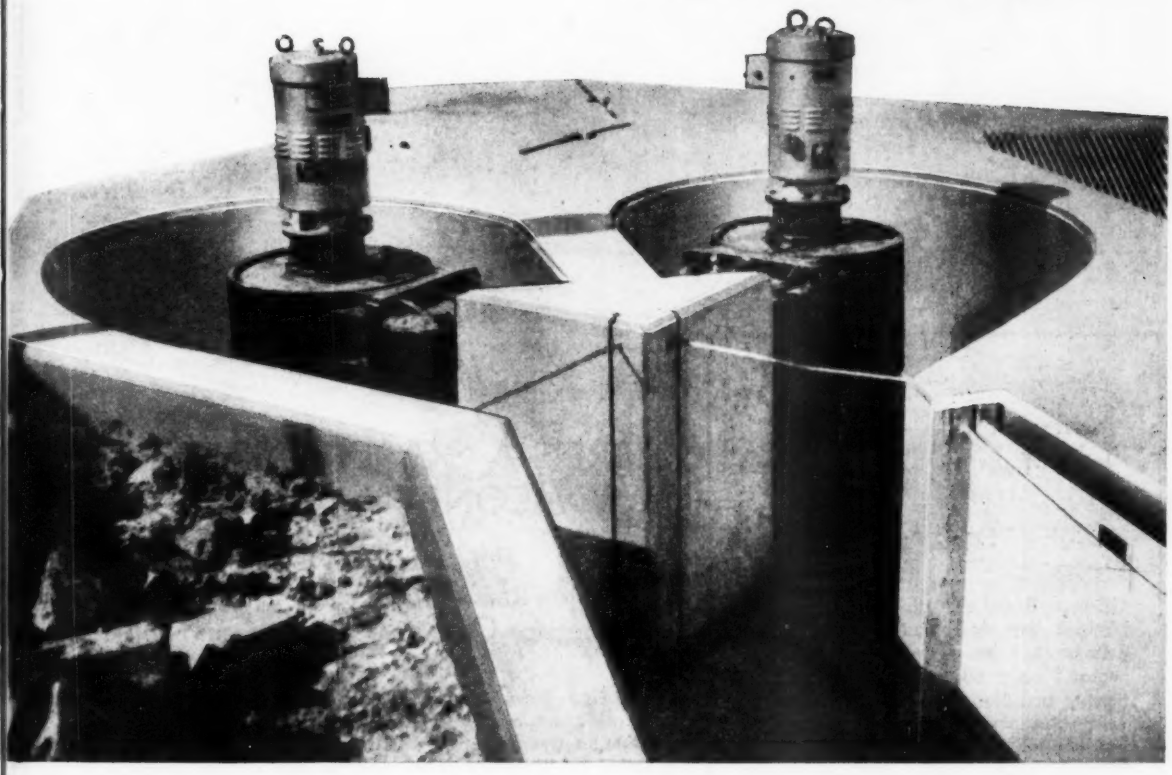

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VOL. 78 PUBLIC WORKS No. 5

Published monthly by PUBLIC WORKS JOURNAL CORPORATION, 310 East 45th St., New York 17, N. Y. Subscription Rates: U. S. A. and Possessions, $3.00. All other countries, $4.00.

MAY, 1947

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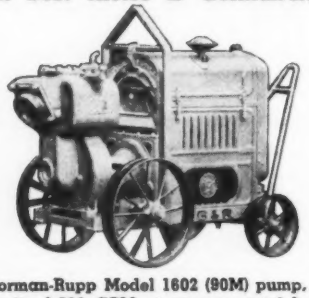
Whatever size your pumping job may be, up to 125,000 gals. per hour, your best choice is Gorman-Rupp.



Gorman-Rupp Model 1602 (90M) pump, capacity 1,500 GPM at average total head.

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For further information and descriptive literature write

THE GORMAN-RUPP COMPANY

GORMAN-RUPP PUMPS — UNSURPASSED FOR PUMPING FAST

320 NORTH BOWMAN STREET, MANSFIELD, OHIO

When you need special information—consult the classified READERS' SERVICE DEPT., *pages 69-73*